MARCH 1960

Power Engineering

ATOMICS . . . Special Bi-Monthly News Report From the Field 41

Designing of Field-Erected Steel Tanks 58

From Here to the Ultimate – What's in Between? 62

Automatic Power Control Raises Precipitator Efficiency 64

Sewage Gas Provides Power at Hamilton, Ohio, Treatment Plant 65

Changing Steam Conditions? Don't Discount Your Old Turbine Generator 67

Tips to Follow for the Better Maintenance of Transformers 72

Almasol Is the Key to New Vistas of Lubrication 76

How to Maintain Flexible Coupling Alignment 77

Packaged Heat Pump Cuts Cost of On-the-Job Erection 79

Dale Generating Station Spray Pond Needs No Pumping Power 80

Power Engineers Await Opening of the American Power Conference 83

Fundamentals of Steam Power Cycles for Better Steam Turbine Operation 84

Long Beach Begins Water Injection Program to Stop Land-Sinking 86

Here's a Simple Method to Help You Keep Track of Tools 87

Questions and Answers About Cyclone-Fired Boilers 88

REGULAR DEPARTMENTS

Engineers' Preview	3	Equipment News	92
What They Tell Us	6	Catalog Library	105
Helpful Bulletins	25	Reader Service Post Cards	105
TRACERS	57	Construction News	118
News Reel	70	Advertisers' Index	120
POWER ENGINEERING Handbook	87	Circulation of This Issue	43,076

a large package boiler that will give you maximum efficiency and economy

You get most efficient steam generation when you select a boiler that's designed for your specific duty range. The B&W Type FO Package Boiler is your best buy if your requirements are in the range of 50,000 to 100,000 lb/hr. Not an enlargement of an existing product but a completely new oil and gas-fired boiler, the Type FO is engineered to give maximum efficiency, economy and quality.

. . . Check these B & W Type FO Package Boiler Benefits

Optimum Output because heating surface and furnace volume are properly balanced. And because B&W builds both the boiler and burner, they go together as a completely integrated steam generating package.

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Greater Efficiency Over Entire Operation Life optimum heat absorption—top burner performance—forced draft operation—constant steam temperatures over a wide load range.

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Whatever *your* particular steam requirements, check with B&W engineers when making your decision. You'll find a range of package boilers with industry-leading features. Call your local B&W representative or write direct to The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

G-912

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BOILER DIVISION

For more data circle 501 on Post Card

New Nalco Coagulant makes Larger, Heavier Floc . . . Faster

Radically different Nalcolyte 110 used with Conventional Chemicals to Cut Costs, Speed Action in Water Clarification

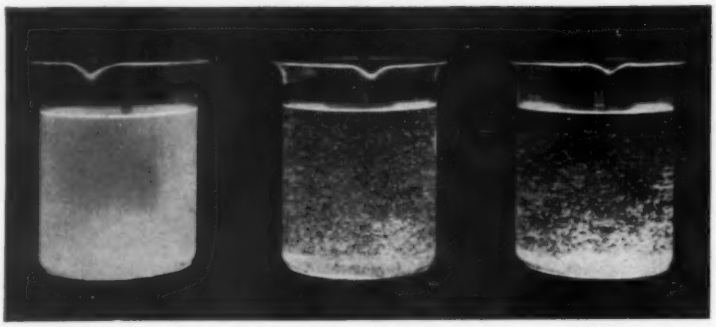

Photo taken in Nalco Laboratories 7 seconds after agitation stopped: *Left*, Control sample of untreated turbid water; *center*, same water, treated with 50 ppm alum; *right*, same water, treated with 20 ppm alum, 1 ppm Nalcolyte 110. Note that large, dense floc is settling out much more rapidly than center alum-treated sample.

Nalcolyte 110 is a new, non-ionic high polymer flocculant of very high molecular weight—over 1,000,000. It is used in extremely small dosages with conventional coagulants (such as sodium aluminate, alum, ferric sulfate) to increase size, density and uniformity of floc.

Less Chemical; Greater Capacity

Action of Nalcolyte 110 in creating heavier, larger, faster-settling floc not only permits greater throughput rates without floc carryover to processing equipment, but also cuts the total chemical requirements at a resultant cost saving.

In the example illustrated above, only 40% as much alum is required when Nalcolyte 110 is used.

May be Used in Potable Waters

Approved by the U. S. Public Health Service Technical Advisory Committee for use in treatment of public water supplies, Nalcolyte 110 gives water works the opportunity to get appreciably greater capacity from existing clarification equipment—at lower treating cost.

High Suspended Solids No Problem

Waters containing high suspended solids respond quickly to Nalcolyte 110 coagulating action . . . frequently without other coagulant chemicals.

Typical high suspended solids waters which can be treated with speed and economy with Nalcolyte 110 are paper mill white water systems, industrial waste waters, mineral slurries and blast furnace gas wash water slurries.

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Nalcolyte 110 is a coarse, white, free-flowing powder of non-toxic character. It is fed in dilute water solutions with standard liquid proportioning pumps or feeders. Stock solutions are prepared at concentrations up to 20%. Packaging is in convenient 25-lb. bags.

Data Available Promptly

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PUBLISHED SINCE 1896 FOR POWER ENGINEERS IN PRIVATE AND PUBLIC UTILITIES AND INDUSTRIAL ARTS

ENGINEERS' PREVIEW

EVER SEE a boiler plant within another boiler plant? If you go into some of our large, modern central stations, you'll see exactly that. This is especially true of the newer high-pressure high-temperature plants where they use small boilers, usually package type, to supply space-heating systems for the entire plant, instead of using up some of the valuable high-pressure high-temperature steam from the main boilers.

Another use of such smaller separate boilers is to supply steam for soot-blowing and de-slagging in the main boiler units. Such an installation has been made at the 5000-psig Eddystone Station of Philadelphia Electric Co, which was pictured under construction in the June, 1959 issue of POWER ENGINEERING, page 90. Here three 500-psig, 39,500-lb-per-hr, oil-fired, Foster Wheeler boilers will supply steam to Vulcan retractable soot blowers and wall de-slaggers, which are operated electrically through selective sequence automatic control.

WORTHINGTON CORP is introducing a series of nation-wide steam power symposiums, consisting of a wide screen color film presentation, a series of prepared visual demonstrations, and individual product presentations by key Worthington executives. The symposiums in 1960 will play host to a leading utility in each of about 15 cities across the country. First one was held in Newark, N. J. for the Public Service Electric & Gas Co. Seven men from Worthington's Harrison (N. J.) Division will travel with the symposium "package."

INDUSTRY BRIEFS: NISA will become "EASA" on April 1, 1961, when the name of the National Industrial Service Association, Inc, is officially changed to Electrical Apparatus Service Association, Inc.

General Electric has reorganized its Apparatus and Industrial Group into two components, an Industrial Group and an Electric Utility Group. Arthur F. Vinson heads the first; Clarence H. Linder heads the new Electric Utility Group. This group comprises the switchgear and control division, transformer division and turbine division.

Houghton Laboratories has changed its name to Hysol Corp.

Crane Co has purchased the business and assets of the Swartwout Co, Cleveland manufacturer of electronic controls. Swartwout will operate as a division of Crane.

JAMES F. FAIRMAN, senior vice-president, Consolidated Edison Co, has been awarded the 1959 Edison Medal by AIEE. The citation accompanying the Medal was "for outstanding performance in improving the design of large electric power systems; for far-sighted leadership in atomic power development; and for unremitting efforts to improve the engineering profession." Fairman has over-all responsibility for the nuclear electric generating station Consolidated Edison is building at Indian Point in Westchester County, N. Y.

Following have been elected to two-year terms on ASME's Joint Research Committee on Boiler Feedwater Studies: chairman, L. Drew Betz, president of Betz Laboratories, Inc; 1st vice-chairman, R. A. Lorenzine of Foster Wheeler Corp; 2nd vice-chairman, J. D. Ristroph of Virginia Electric Power.

Philip D. Reed has retired from the General Electric Co after a career of 33 years in the company. He joined GE on November 15, 1926, one day before his 27th birthday, and was elected chairman of the Board on November 17, 1939, one day after his 40th birthday. Preparatory to retirement, he resigned as board chairman in 1958.

Noah E. Hull, vice-president and general manager of the Hughes Gun Co and assistant to the vice-president, manufacturing, of the

Hughes Tool Company, Houston, Texas, has been nominated for the office of president of the National Society of Professional Engineers.

Andrew R. LeBailly, partner and chief engineer of Sargent & Lundy, has reached retirement age and resigned from the partnership. He spent over 32 years in service with the firm. The position of chief engineer will be filled by Henry C. Schroeder, partner and former chief mechanical engineer. Schroeder's former duties will be taken over by Harry H. McMeen.

Clarence H. Linder, a vice-president of General Electric Co, has been nominated to be 1960-61 president of AIEE.

Dr. Edgar A. Sack, Jr, who has distinguished himself in work at the Westinghouse Research Laboratories and in activities in his community, has been chosen the "outstanding young electrical engineer" for 1959 by Eta Kappa Nu Association.

Clarence B. Campbell, chief engineer of the Westinghouse steam division, has been awarded the Gold Medal of the Newcomen Society in North America "in consideration of his many outstanding achievements in the utilization of steam for the benefit of mankind."

Francis K. McCune has been appointed vice-president of engineering services for General Electric Co. McCune has served as vice-president for atomic business development since February, 1959.

BIBLIOGRAPHY of 290 technical references in the field of gas lubricated bearings has been prepared under government contract by the Franklin Institute Laboratories and is for sale by the Office of Technical Services, Business and Defense Services Administration. Price is $2.50. Address orders to OTS, U. S. Department of Commerce, Washington 25, D. C.

References to the literature on research, development, and application of thermoelectricity, accumulated by the Library of the U. S. Naval Research Laboratory, are contained in two volumes just released for sale through OTS. The two volumes appear under the same title, Thermoelectricity Abstracts. They are PB 151657, $2.50; and PB 151810, $2.25.

MEETINGS: Gas turbine power and hydraulic divisions, ASME, will meet at the Rice Hotel, Houston, Texas, March 6-9.

National Electric House Heating Exposition is scheduled for March 21, 22 and 23, at Chicago's Sherman Hotel. Sponsor is NEMA. This is a "first" of its kind.

32nd annual PIEA-PESA conference and exhibition will be held in Kansas City, Mo, April 12-14, at the Municipal Auditorium and Muehlebach Hotel. Sponsors are the Petroleum Industry Electrical Assn and Petroleum Electric Supply Assn.

AIEE will sponsor the first special conference on electrical engineering in space technology, April 11-13 in Dallas, Texas, Baker Motel.

41st annual convention of the American Welding Society will be held April 25–29 at the Biltmore Hotel in Los Angeles. The annual Welding Exposition will be held concurrently, April 26–28, at the Great Western Exhibit Hall.

TVA's power operations produced total revenues of $237,500,000 from which TVA realized a net income of $50,800,000 for the fiscal year ending June 30, 1959. Power sales totaled 57.2 billion kwh, half a billion more than in the previous year. Power expenses totaled $186,-700,000, or $8,100,000 more than the year before. Production expense amounted to $116,100,000, of which $83,700,000 was for coal. Although power revenue was $4,000,000 greater than in 1958, TVA's net income was $4,100,000 less. Main reason is given as less favorable water conditions, necessitating greater fuel expense for the steam plants.

LONG ISLAND'S first graduate engineering school will be established in Farmingdale by the Polytechnic Institute of Brooklyn. It will be known as the Polytechnic Center for Graduate Study and Research. Curricula will be restricted to graduate study with full-time and part-time programs leading to master's and doctor's degrees in aeronautical, electrical and mechanical engineering, and in physics and mathematics. Present plans call for facilities for approximately 1000 students.

The Schools of Civil and Mechanical Engineering at the University of Pennsylvania, which have long been separate units, will be combined to form the Towne School of Civil and Mechanical Engineering.

SILENT SAM, the smog detective, is a long-range infra-red spectrometer which not only identifies air pollutants in the ppm range, but also brews its own synthetic smog for experimental use. It's one of the results of the air pollution research program being sponsored by the American Petroleum Institute. Since 1952, API has invested more than $1,300,000 in this program. In addition, individual oil companies have spent $66,000,000 in the same period for the development of air pollution controls.

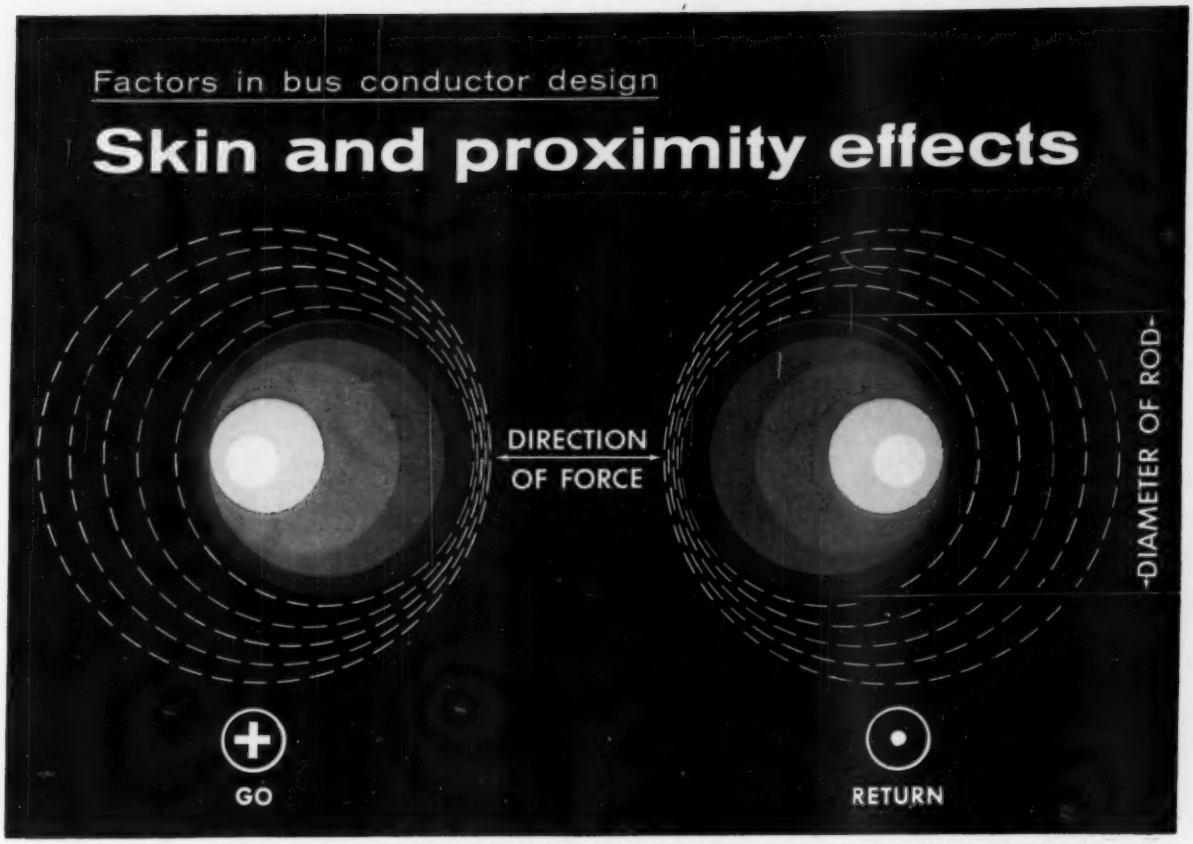
SIX 6000-kw gas turbine generator units have been ordered by Hydro-Quebec from Canadian General Electric for the Gaspe Region. They will be located next to the Commission's substation at Les Boules, and will function as standby plant, as peak plant to add to power supply, and as synchronous condenser plant to promote ideal conditions on the system.

STUDY of methods of converting various forms of energy directly into electricity has been initiated by the Edison Electric Institute. To take about a year's time, the study has as its objective the evaluation of the potential of each direct conversion method for the bulk production of electricity. Theodore Baumeister, Steven Professor of Mechanical Engineering, Columbia University, will conduct the study under the direction of an EEI steering committee. Committee chairman is J. G. Miller, Metropolitan Edison Co.

INTERNATIONAL standardization of extra high voltage transmission of electric power has been suggested by Philip Sporn, president of the American Electric Power Service Corp, and by H.P. St. Clair, the company's planning and operating engineering manager. They propose that 500,000 volts be adopted, and that consideration be given to 690,000 or 750,000 for the distant future.

Factors in bus conductor design

Skin and proximity effects



Dotted lines indicate magnetic fields. Color shading illustrates the resultant distribution of alternating current in round rod conductors. Mechanical force is developed as the centers of current try to move into the centers of their magnetic fields.

Low skin-effect ratio favors tubular shape

Skin effect becomes increasingly important in the medium and larger sizes of bus conductors carrying alternating current. It is the basic reason for using tubular conductors, quite apart from the structural advantages which they also possess. Tubular shapes (round or square) and paired channels have low skin-effect ratios, i.e., low effective resistance to alternating current.

Skin effect is, essentially, the crowding of the main alternating current flowing in a conductor toward the outside surface by a contrary flow induced in the center of a solid conductor, a cable, or in the inner annular area of a tubular conductor by the constantly varying magnetic flux surrounding it.

Proximity effect is uneven distribution of an electrical current over the cross section of a conductor due to distortion of the surrounding magnetic field by the field or fields generated by current in neighboring conductors. The practical result of "proximity" is an increase in the apparent resistances of the conductors affected. Mechanical forces also are generated.

Field and current distribution problems are two of the many which complicate bus design. The Technical Department of The American Brass Company is always available to engineers for consultation in the selection of Bus Conductors for specific needs. See your Anaconda representative, or address: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

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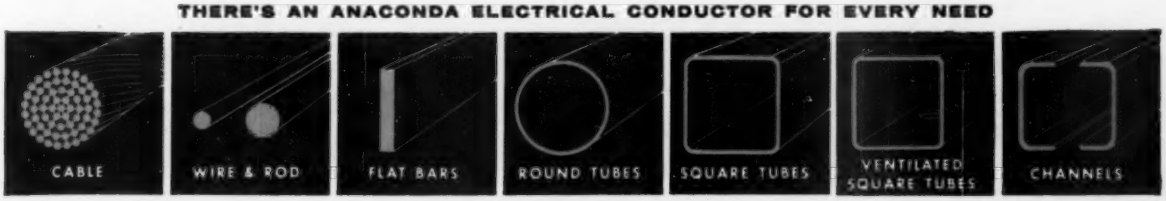

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WHAT THEY TELL US

▶ **OUR ALL-OUT EFFORT** in the January issue to present well-rounded basic thinking on automation in the power field has drawn a rousing response from readers. Requests for reprints keep rolling in. Typical of comment:

> The special report which you published in the January, 1960 issue of your magazine on Automation and the Power Field is an excellent contribution to understanding by engineers of the role of the computer and the rapid strides with which automated operation is taking over the power field. I would appreciate a reprint of this group of articles for permanent reference.
>
> William Kowalsky, vice-president, J. R. Miller Co, consulting engineers, New York City

> Our congratulations for your very excellent and important January issue. We certainly hope all your readers attach the importance to this issue that we at Hagan have given it.
>
> Daniel J. Dougherty, assistant advertising manager, Hagan Chemicals & Controls, Pittsburgh

> You have done an excellent job and are to be complimented.
>
> Theodore Baumeister, consulting engineer, General Public Utilities Corp, New York City

> Congratulations on an outstanding piece of work.
>
> Floyd G. Scammon, plant engineer, Penobscot Chemical Fibre Co, Old Town, Maine

> I would appreciate it very much if you would please send me a reprint of the fine series of articles on Automation published in the January issue.
>
> Professor Herbert F. Roemmele, Cooper Union, New York City

> We would be obliged if you will send us ten reprints of the section covering Automation and the Power Field. We would like to have these for distribution to our engineers . . .
>
> L. M. Sheehan, Gibbs & Hill, New York City

> I have read with considerable interest the section on Automation and the Power Field. Can you please send me a reprint of this section?
>
> P. R. Grossman, director of research, Babcock & Wilcox Co, Alliance, Ohio

> Kindly send me one reprint of the excellent set of articles in the January issue, under title of Automation and the Power Field.
>
> Lloyd V. Phillippe, design draftsman, U. S. Steel Corp, Clairton, Penna

> I have just read the special report on Automation and the Power Field in the January issue and found it to be a comprehensive compilation of the many facets involved in automation and the power field to date. I should be pleased to receive a copy of this report for my personal file.
>
> M. J. Palie, Stone & Webster Engineering Corp, Boston

> Would you please send three copies of your very excellent report, Automation and the Power Field. I am one of several readers of your magazine that comes to our company.
>
> W. H. Osterle, manager, research and development dept, West Penn Power Co, Greensburg, Penna

> Your January special issue contains an excellent presentation of the fundamentals involved in the application of computers for the automation of a steam-generating plant.
>
> H. B. Marshall, engineering dept, Central Maine Power Co

> I would much appreciate two reprints of your special report on Automation and the Power Field, a first-rate survey of developments in this field.
>
> B. F. Gill, efficiency engineer, Hydro Electric Power Commission of Ontario

> May I congratulate you on your splendid coverage of control computers and their present and future use in power systems. It is stimulating and imaginative reading and I would like to make this issue of POWER ENGINEERING "must" reading for all engineers in my section.
>
> W. A. Frankenfield, supervising engineer, system relaying section, The Detroit Edison Co

> It was obvious from the format and the stature of the people involved that a great deal of effort must have gone into bringing together such a well-coördinated and informative series. I feel that it was one of the most well-rounded packages for presenting all sides of the automation picture to the industry.
>
> John H. Wright, manager of customer service and education, Daystrom Systems

▶ **DO YOU SAVE** pages from POWER ENGINEERING'S Handbook? Reader James W. Sheffer of the Philadelphia Quartz Co has an idea for tear-out handling of these pages:

> Your Handbook portion of the magazine is always interesting, and I have saved a number of the articles from this section.
>
> The method suggested for folding and punching contemplates facing the pertinent Handbook pages toward each other and inserting, so that every other page consists of unrelated matter (from the back of the original magazine sheet).
>
> Why not fold in the opposite direction (around the same dotted line) and punch what were formerly the top and bottom edges of the magazine page? The fold will then be at the edges of the Handbook, and the extraneous matter hidden away.

▶ **A. THOMSON,** a dircetor of the Pyropress Engineering Co Ltd of Kempston, Bedford, England, writes:

> Many thanks for the copy of your October issue, which includes the article around crankcase explosion relief valves of the type manufactured by us. I must congratulate you for a very well-written article, which I trust will be of interest to many of your readers who may either build or use diesel plant.

▶ **NEWS** comes through that Soviet engineers have just finished designs for the USSR's first tidal power station. It will be located in the eastern part of the Mezen Bay, White Sea, where tides of from 23 ft to 33 ft have been measured. Writes Rudolph Sobotka:

> This part of the bay is to be spanned with a 62-mile-long sectional ferro-concrete dam in which are to be installed 2000 turbines. The electricity is to be fed into the unified grid of the Urals and the European part of the Soviet Union.
>
> Alternation of idle and generating periods, caused by ebb and tide, is considered a shortcoming in tidal power stations. Soviet engineers are convinced, however, that the great advantage of sea tides lies in their constant average tidal energy.
>
> Prefabricated, rectangular reinforced concrete slabs up to 4 in. thick are to be used as building material for the tidal power stations. In this way, docks will be built on the shore, then towed to the construction site and sunk.
>
> The station will have bulb-shaped turbine generators, which are known to work smoothly under the effect of alternating water currents. They are fully submerged and therefore need no machine covering.

3 STORIES HIGH

200,000 sq. ft. condenser for Widow's Creek Station of TVA

or BROAD and LOW

YUBA CONDENSERS—with the most flexible tube bank layout in the industry—designed to fit any plant or space requirements

This is a three story high, twin-bank condenser—just one of many tube bank layouts possible with Yuba Condensers—most flexible in the industry. Whether you require a giant condenser or a small one, in a single or multiple pass or axial flow design—no matter what the size, type or service conditions, Yuba's flexible design paces the progress in the power industry.

Yuba's twin-bank tube layout, for example, permits turbine exhaust steam to flow unobstructed, with equal distribution throughout the entire tube bank with a free flow to bottom of condenser and into hotwell, where it reheats and deaerates condensate. In Yuba's deaerating condensers, the oxygen in the condensate is guaranteed to be less than 0.005 cc per liter. This design is patented.

For that extra performance, Yuba staggers the tube support plates—reducing harmonics—eliminating vibration. This is just another reason Yuba surface condensers have been installed all over the world in plants of many sizes. For full details, contact Yuba today.

Other Yuba products for steam power plants include Feedwater Heaters, Evaporators, Expansion Joints, Cranes, Tanks, Structural Steel and scores of other items.

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Why do industrial plants, institutions, universities and central heating plants SPECIFY and INSTALL Yarway Gun-Pakt Expansion Joints?

Because with Yarway you get:

- **CONTINUOUS SERVICE**

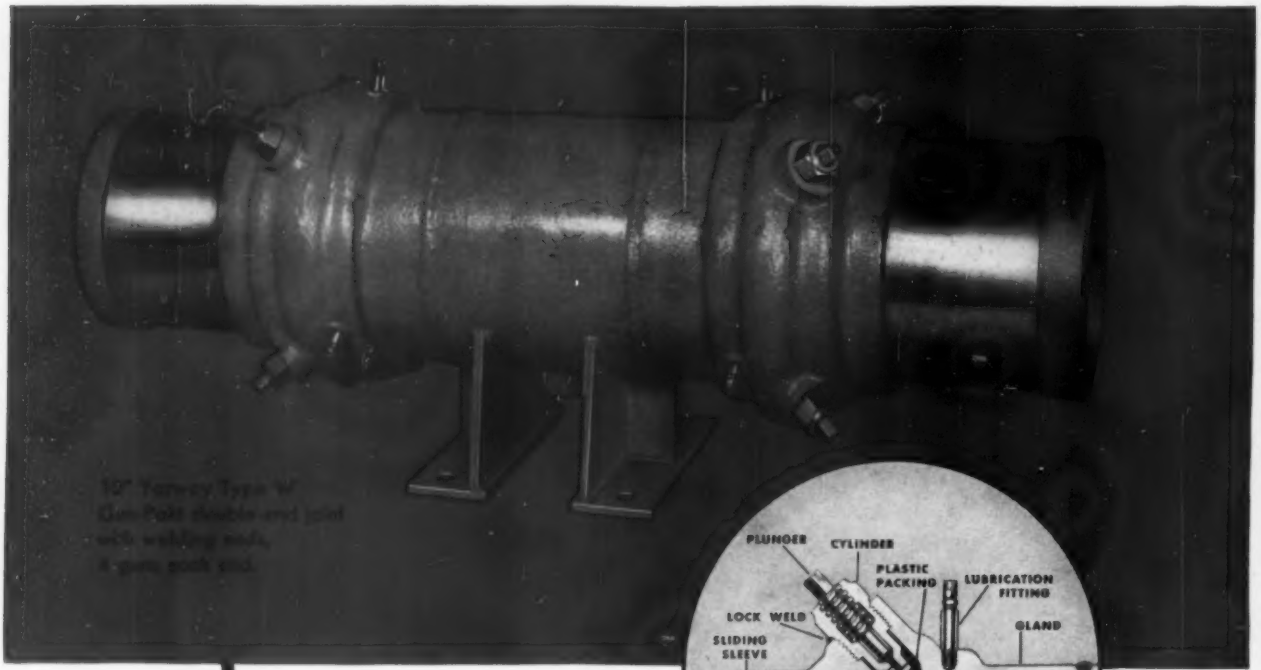
  Costly shutdowns are eliminated. Packing is seldom necessary but may be added *under full line pressure*. No vents are necessary. Never needs repacking.

- **RUGGED DEPENDABILITY ALL STEEL CONSTRUCTION**

  Durable chromium plated seamless steel sleeves. No chance *of metal fatigue*. Wrought steel bases provide rugged, positive anchorage.

- **INTERNAL AND EXTERNAL GUIDES**

  Positive alignment of sleeve in stuffing box—*where it counts!*



Cross-section of Gun-Pakt feature. To add packing, just insert a plug and turn the plunger. Note non-return packing slots.

when you install EXPANSION JOINTS

- **LIGHT WEIGHT, STREAMLINED DESIGN**

  Requires less space to install—less space to maintain—smaller manholes.

Many Gun-Pakt joints have been *in service over 25 years with only nominal maintenance* —no major repairs or periodic overhauls. Maintenance costs are negligible—records show average to be one manhour and 65 cents worth of packing per joint per year. AND—NEVER A SHUTDOWN FOR REPACKING!

YARWAY field engineers are qualified to advise on installation and service—at no cost to you. Investigate today. Write for Bulletin EJ 1917 ('59).

FOR YOUR NEXT PIPELINE JOB—BE SAFE—BE SURE! SPECIFY YARWAY GUN-PAKT.

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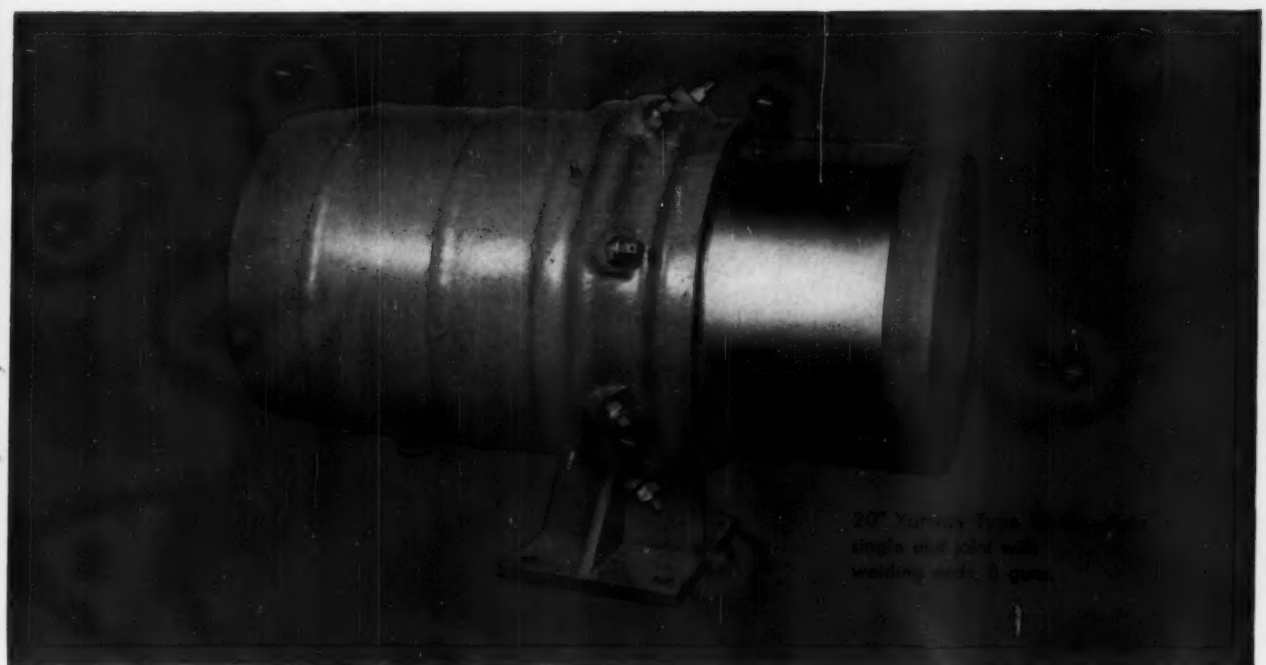

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Coal cuts fuel costs $5200 a year

Hinsdale High School uses just 1450 tons of coal a year, saves on fuel and handling costs

When Hinsdale Township High School, Hinsdale, Ill., was designed, an engineering survey on the cost of steam generation was conducted simultaneously. (Steam would be used principally for heat, hot water, swimming pool and laundry.) The survey dictated the selection of coal for lowest fuel costs and a completely modern coal-fired plant was designed for maximum efficiency and economy. Today, outstanding features of this coal burning plant are: one-man operation, economy in labor and fuel, mechanical coal and ash handling and low maintenance costs. The decision to use coal saves this relatively small coal-burning plant $5200 in fuel costs annually over the nearest competitive fuel.

COAL IS LOWEST COST FUEL

Today, *when the annual cost of fuel often equals the original cost of the boilers,* you should know that bituminous coal is the lowest cost fuel in most industrial areas. And modern coal-burning equipment gives you 15% to 50% more steam per dollar, while automatic operation trims labor costs and eliminates smoke problems. What's more, tremendous coal reserves and mechanized mining procedures assure you a constantly plentiful supply of coal at stable prices.

CONSULT AN ENGINEERING FIRM

If you are remodeling or building new heating or power facilities, it will pay you to consult a qualified engineering firm. Such concerns —familiar with the latest in fuel costs and equipment—can effect great savings for you with the efficiency and economy of coal.

TECHNICAL ADVISORY SERVICE

To help you with fuel problems, the Bituminous Coal Institute offers a free technical advisory service. We welcome the opportunity to work with you, your consulting engineers and architects. If you are concerned with steam costs, write to address below or send coupon. Ask also for case histories booklet, complete with data sheets. You'll find them informative.

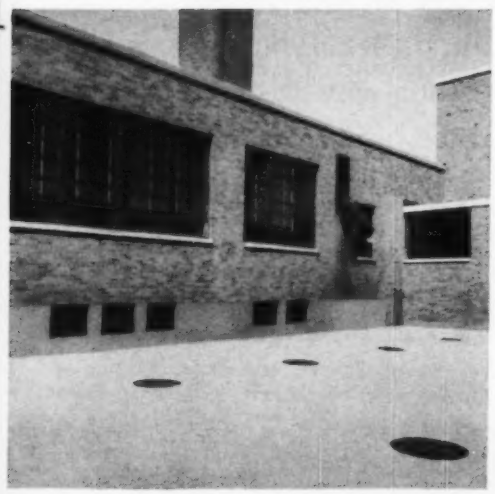
BITUMINOUS COAL INSTITUTE

Department PE-03, Southern Building, Washington 5, D. C.

See our listing in Sweet's Files: A-30J/Bi; PE-4a/Bi; IC-18/Bi

Three boilers in foreground are Kewanee Type C fire-tube units, rated at 20,000 sq. ft. radiation, fired by Iron Fireman single-retort stokers, with 1000 lb/hr coal feeding capacity. At rear is Kewanee gibbons Type D firebox boiler, rated at 29,000 sq. ft. fired by Iron Fireman stoker, 1200 lb/hr capacity.

Exterior view of power plant. Coal is gravity fed from trucks through manholes into 600-ton storage bin. It is then moved by Hager screw conveyor to stokers. Ashes move from ash room by Webster bucket conveyor to chute (on right) for disposal.



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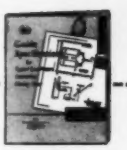
Guide Specifications, with complete equipment criteria and boiler room plans:



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Bituminous Coal Institute
Southern Building, Washington 5, D. C.

Gentlemen: Please send me:

- ☐ GS-1 (low-pressure heating plant, screw-type underfeed stoker).
- ☐ GS-2 (high-pressure heating and/or process plant, ram-type underfeed stoker).
- ☐ GS-3 (automatic package boiler for heating and process plants).
- ☐ Case histories on larger plants.

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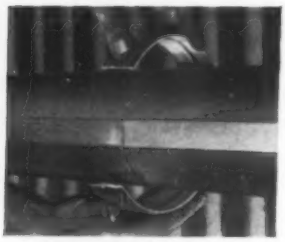
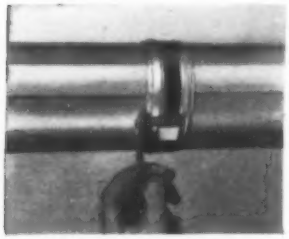
Now! Ready-to-install in a single package
• Thermobestos calcium-silicate insulation
• Gleaming, weatherproof aluminum
• Integral isolation felt

Remove from carton and Metal-On is ready to install. Just snap on pipe and lock in place.



... the specially designed aluminum "snap strap" (containing vapor seal) is snapped on joint...



... Metal band completes the assembly ... provides perfect joint protection against vapor and weather. Available in many colors, the Metal-On band also serves color coding purposes.

Two men completed 660′ Metal-On

New Johns-Manville Metal-On insulation is today's fastest and most efficient way to install high-temperature pipe insulation... and protective metal jacketing

Metal-On is still new! It is just months since its introduction—yet it has already been accepted by virtually every industry in which high-temperature pipe insulation needs protective metal jacketing.

One reason for this rapid, all-out acceptance is Metal-On's installation economy. A single package product that consists of high-temperature insulation and protective aluminum jacket—Metal-On entirely eliminates separate on-the-job metal application. In

Part of 2100-foot Metal-On installation. New plywood plant of the Winton Lumber Co., Jackson, Cal. Insulation Contractor: Western Asbestos Co., San Francisco.

Metal-On pipe insulation presents no fitting problem. It is cut easily right on the job with either power or hacksaws. Available in long, 3-foot sections in a complete range of pipe sizes through 24" . . . by 3" thickness.

this insulation job in one working day!

fact—a section of Metal-On can be applied at least as fast as pipe insulation alone.

However important installation speed may be, it is but one Metal-On advantage! For Metal-On also ends guesswork in specifying aluminum alloys and jacket thicknesses. Its jacket measures an ideal .016" thick . . . of a high-quality aluminum alloy selected expressly for superior weather resistance . . . good appearance . . . and resistance to abuse and pitting.

Of course, Metal-On never needs painting. Won't rust. Is impervious to dirt, oils and grime. And, unlike corrugated metal jacketing, Metal-On has no dirt-collecting grooves—its smooth surface stays clean.

Metal-On also provides top fuel savings and accurate temperature control, because its insulating element is Johns-Manville Thermobestos®, finest of all the calcium silicate insulations for temperatures to 1200F. The conductivity of Thermobestos is lowest of all insulations generally used in power and process industries.

To help you compare Metal-On with the insulation you're now using—let us send you the new technical data brochure, IN-217A. Write for it today. Address Johns-Manville, Box 14, New York 16, N.Y.

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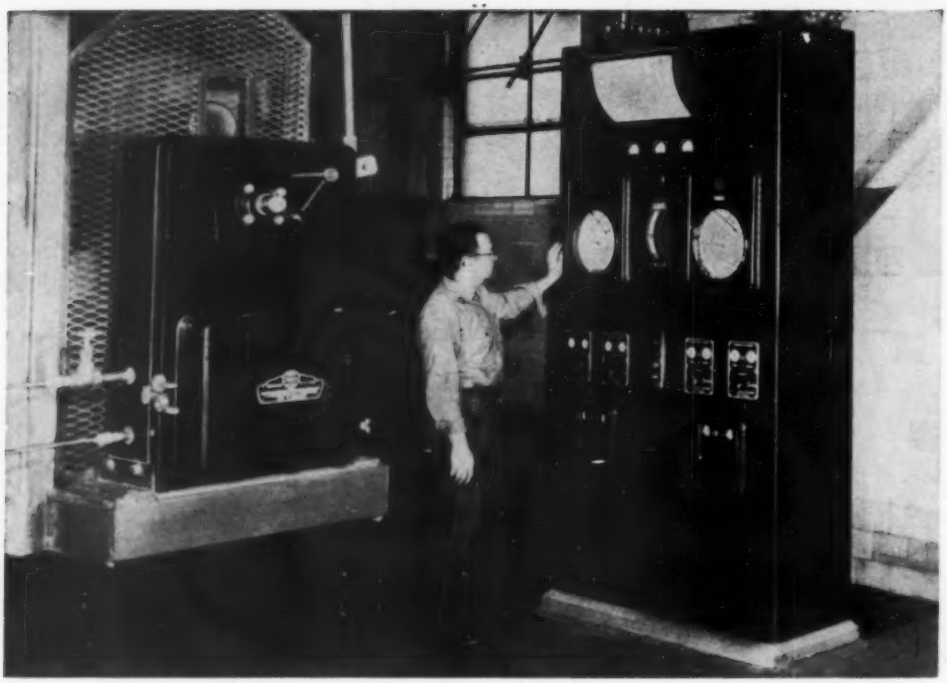

This Bailey Control System helps cut fuel costs on a 70,000 lb per hr capacity 125 psi boiler in an industrial plant. Control drive in foreground regulates stoker.

How Bailey stretches your fuel dollar...

You can wring more energy out of a dollar's worth of fuel when you are getting optimum performance from your steam plant equipment. You get peak performance when Bailey Meters and Controls are on the job. They increase your plant efficiency.

Bailey is the choice of virtually all the most efficient plants on the Federal Power Commission's heat rate report. Here's why:

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You can be sure a Bailey Engineer will offer the right combination of equipment to fit your needs. Bailey manufactures a complete line of standard, compatible pneumatic and electric metering and control equipment that has proved itself. Thousands of successful installations involving problems in measurement, combustion, and automatic control are your assurance of the best possible system.

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Bailey Engineers have been making steam plants work more efficiently for more than forty years. Veteran engineer and young engineer alike, the men who represent Bailey, are storehouses of knowledge on measurement and control. They are up-to-the-minute on the latest developments that can be applied to your problem.

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There's a Bailey District Office or Resident Engineer close to you. Check your phone book for expert engineering control on your steam plant control problems.

A132-1

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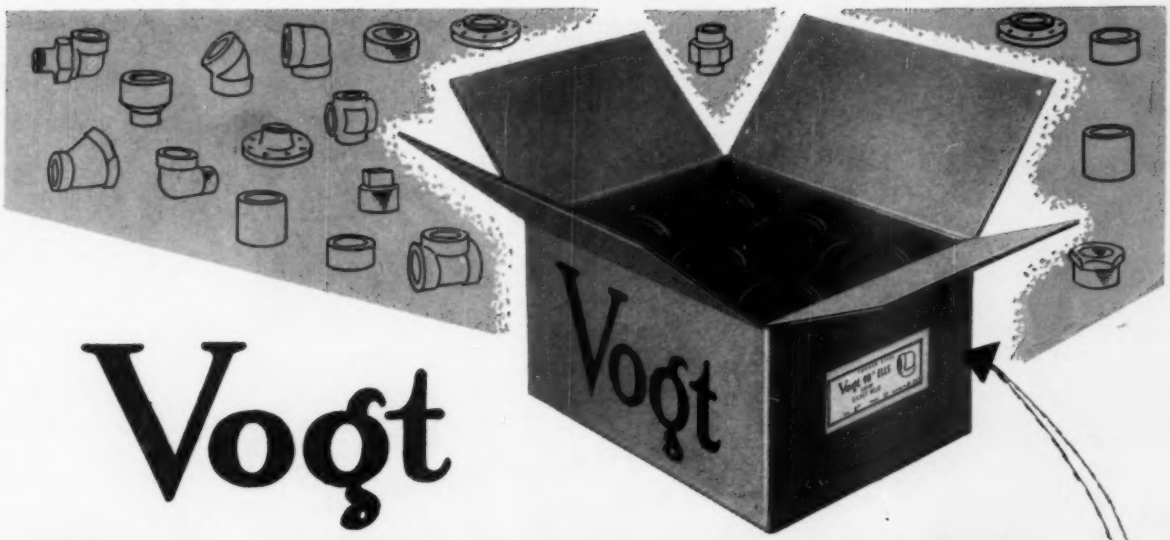
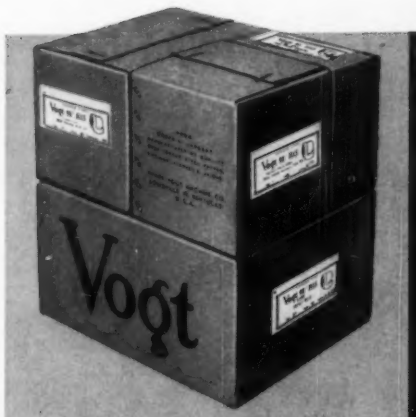


Vogt PACKAGED

FORGED STEEL FITTINGS, FLANGES and UNIONS

Complete product identification and data on label attached to carton.



Vogt modular designed cartons give added handling and storage space economies. All dimensions are in multiples of 3 inches.

for

MATERIAL HANDLING ECONOMY

1 Easy Inventory Identification

2 Easy Handling

3 Protection Against Damage

Handling and inventory costs are held to a minimum with Vogt modular packaged forged steel fittings, flanges, and unions. The small cartons, of restricted weight, are appreciated by the distributor and user alike for their easy handling and the protection given the products against damage.

The label attached to each carton completely describes and pictures the product and gives the quantity, size, end type, pressure, and catalog number.

Write for Folder PF-1 for complete data on quantities and weights of the items as packaged in various sizes of cartons.

Address Dept. 24A-FPE

HENRY VOGT MACHINE CO.
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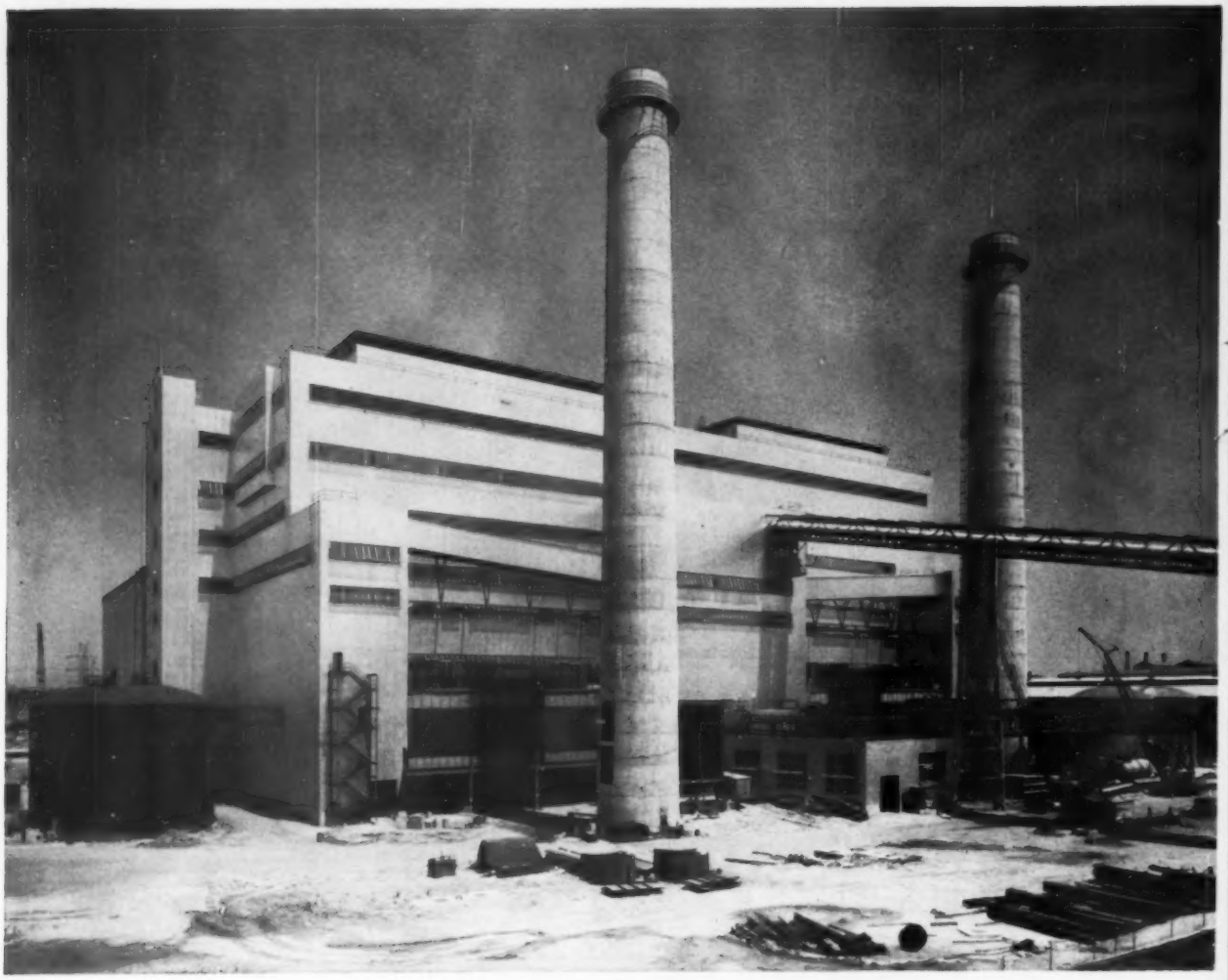


Eddystone Station's Unit 1 has a capacity of 2,000,000 lb/hr at 5000 psig and 1200°/1050°/1050°/F . . . uses C-E Sulzer Monotube Steam Generator.

Vulcan Selective-Sequence system provides Eddystone Station with precision soot blowing

When Unit 1 of Philadelphia Electric's Eddystone Station went into operation, a Vulcan Selective-Sequence system was accurately controlling all soot blowing.

Selective-Sequence systems were chosen for both units 1 and 2 at this super-critical station because they assure positive, dependable boiler cleaning . . . make the most efficient use of the blowing medium.

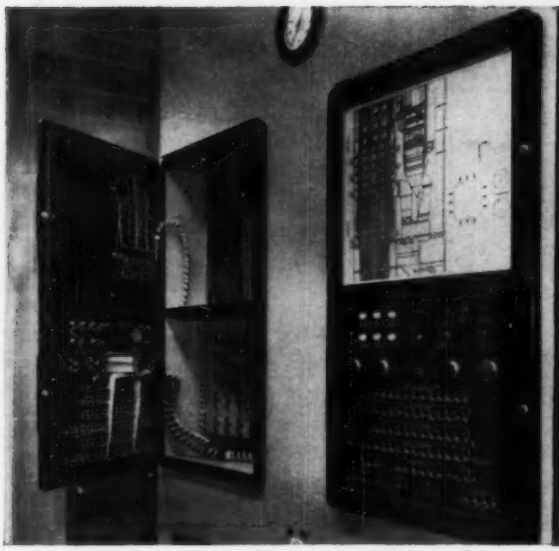
Vulcan Controller saves time. Without leaving the panel, the operator pushes a master button to place the system in sequential operation. He can see that each soot blower is operating in sequence for the proper interval with adequate pressure. He can modify the sequence to improve cleaning or conserve the blowing medium without time-consuming wiring and piping changes.

Vulcan long retractables speed cleaning. With dual-motor drive, Eddystone's T-30's clean uniformly; minimize the danger of tube cutting or erosion. Low rotating speed increases range and penetration of cleaning, decreases wear, eliminates whip, and permits proper cleaning with faster traversing speeds.

Half-'tracts with 19-foot travel, wall deslaggers, and air pre-heater controls are also used.

Copes-Vulcan Division

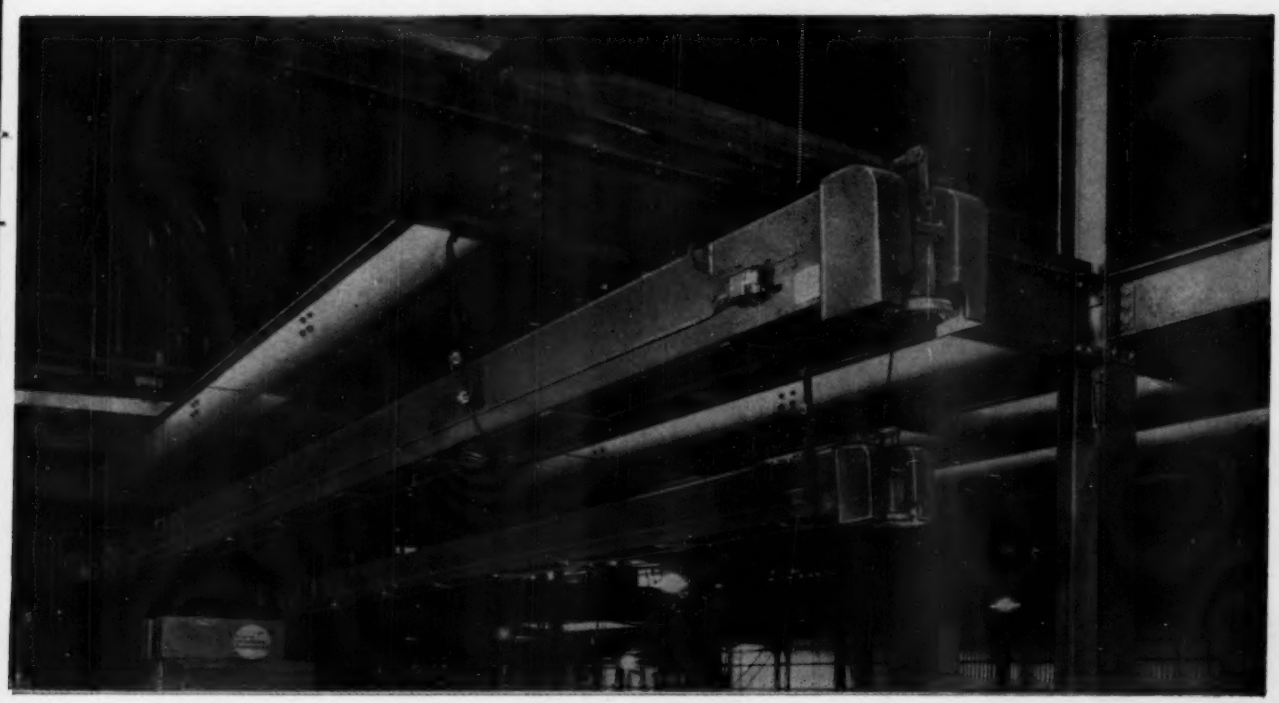
BLAW-KNOX



Panel provides centralized control of soot blowing at Eddystone. With the Vulcan SSC-120 Selective-Sequence controller, each blower can be operated four times during a schedule, or there can be four different schedules. The sequence can be varied by means of a jack board. Any soot blower can be operated at any point in the sequence by plugging one end of a patch cord into the blower jack, and the other end into the desired sequence jack. Write for Bulletin 1029.

Wall deslagger conserves steam generated at Eddystone by three special package boilers. High striking power of Vulcan RW-3E drives off gummy masses to assure high heat-transfer capacity, and uniform superheat and reheat temperature control. Dual motors are used: one speeds the nozzle to and from the blowing position, the other rotates it slowly for thorough cleaning. All parts are covered for protection, assuring long life with low maintenance. Write for Bulletin 1034.

Vulcan T-30's have 30- and 37-foot travels. Motors are mounted at the boiler end to facilitate maintenance, yet away from heat of the boiler wall. Their placement avoids interferences. Write for Bulletin 1030.



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The Story of Edward Research

and the Leak-proof Valve

In the early 1940's, the advance of steam power plant pressures and temperatures demanded a leak-proof, small sized valve—one with permanent tightness at the seat joint and one which would solve the failures of mechanical gasketed bonnet joints under elevated temperatures. The story behind the development of the Edward leak-proof Univalve* (sizes to 2½" in 1500, 2500 and 4500 lb. pressure classes) is the story of the product research that solved this industry problem.

EARLY EXPERIMENTING: Elimination of the bonnet joint entirely, by providing a one piece body-yoke construction, appeared to be a logical approach to the bonnet joint problem. But this created a new problem—how to apply and *how to service* an integral Stellited seat from a distant point at the top of the valve yoke. Some valve manufacturers chose to split the valve body near the seat and then reassemble the body with a full pressure weld. Others chose a full pressure weld at the normal bonnet joint position. Neither approach allowed the user to disassemble the valve and both approaches resulted in the sacrifice of a positive, permanent backseat—a desirable feature in any high-pressure valve. Edward engineers refused to make these concessions.

ENGINEERS FIND SOLUTION: After many attempts, Edward engineers developed a water-cooled welding torch for the application of the Stellite seat. This provided a stress-free Stellite layer of uniform density, firmly bonded to the body, free of cracks and pin hole porosity. Simultaneously, other Edward engineers sought the answer to the bonnet joint leakage problem. Extensive research and testing of a variety of body-bonnet combinations and seal-welding techniques resulted in the four elements of today's proven Univalve bonnet joint—a body-bonnet shoulder, load carrying thread, guiding section for alignment and the seal weld.

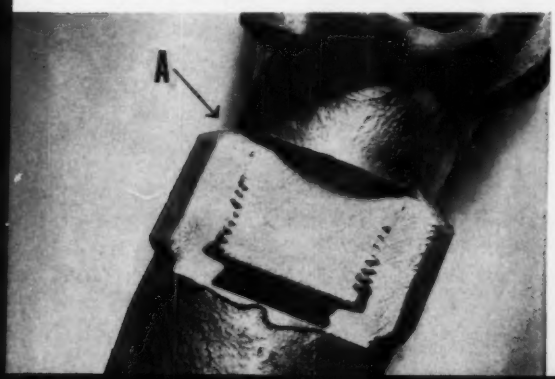
NEW DESIGN PROVES OUT: Months of research testing failed to find a weakness in the new design. Thousands of operations at rated pressure and temperature indicated long-time seat tightness superior to anything previously achieved. Bonnet joint design could not be made to fail at several times the valve rating. Tests were conducted with supercritical steam pressures up to 6000 psi at 1050 F in the only known facilities capable of producing those conditions at that time. And, to date, *hundreds of thousands of Univalves are in service with only one recorded instance of bonnet joint leakage*—a minor defect in the seal weld.

Edward builds a complete line of forged and cast steel valves from ⅛" to 18", in globe and angle stop, gate, non-return, check, blow-off, stop-check, relief, hydraulic, instrument, gage and special designs for pressures up to 10,000 lbs. For more detailed information, contact your Edward Representative, or write Edward Valves, Inc., 1202 West 145th Street, East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company. Represented in Canada by Lytle Engineering Specialties, Ltd., 438 St. Peter Street, Montreal.

EDWARD STEEL VALVES
another fine product by
ROCKWELL

◀ **E. A. STICHA,** Chief Research Metallurgist, and R. K. Wagenblast, Research Engineer, measure temperature of valve seal weld in superheater test loop used in Univalve research.

▼ **DESTRUCTION TESTS IN EDWARD LABORATORIES IN EARLY 1940's**—Bonnet seal weld (A) of test valve cracked only after body creep occurred at 200° F above primary temperature and four times the primary pressure.



CRITICAL LEAKAGE PROBLEMS ATTACKED BY EDWARD RESEARCH ENGINEERS—(A) Bonnet leakage solved by design featuring threaded structural joint and seal weld; (B) Seat leakage solved by revolutionary Stellite seat welding technique.

*T.M. Reg. U.S. Pat. Off.

HELPFUL WATER CONDITIONING DATA FROM BETZ

HOW CORROSION ATTACKS

Boiler, cooling and process water systems are constantly plagued by corrosion. This article tells how and why.

Corrosion can be defined as the destruction of a metal by chemical or electrochemical reaction by its environment. In the corrosion of ferrous metals in contact with moisture, reversion of the metal to the oxide form takes place. The driving force or the tendency to corrode is electrochemical. However, the rate at which corrosion proceeds is largely dependent on the resistance to continued attack by the products of the corrosion reaction.

In industrial water systems, the principal factors influencing corrosion of ferrous metals are the water characteristics, temperature, rate of flow and the contact of dissimilar metals. The chief variables controlling the characteristics of a water are its dissolved oxygen content, carbon dioxide concentration, pH and dissolved solids. Other factors are involved, of course, such as the possible presence of free mineral acid, hydrogen sulfide, sulfur dioxide, etc. In addition, certain bacteria may be a factor.

Dissolved Oxygen

The presence of oxygen is usually essential for serious corrosion to take place in natural waters. Dissolved oxygen will greatly accelerate corrosion in acid, neutral, or slightly alkaline waters.

The corrosion of iron in pure water in the presence of oxygen may be expressed in a simplified way by the following equations:

(a) Fe (iron metal) $+ 2H^+$ (hydrogen ion) $\rightleftarrows Fe^{++}$ (ferrous ion) $+ 2H^\circ$ (hydrogen atoms)

This is the typical primary reaction, in which iron enters the solution as ferrous ions, and hydrogen ions take up the charge and plate out as hydrogen atoms and thus maintain the system electrically neutral. This primary reaction is followed by either the destruction of the film of hydrogen by reacting with dissolved oxygen:

(b) $2H^\circ$ (hydrogen atoms) $+ \frac{1}{2}O_2$ (dissolved oxygen) $\rightarrow H_2O$ (water)

or the hydrogen can be removed as bubbles of gas:

(c) $2H^\circ$ (hydrogen atoms) $\rightarrow H_2$ (hydrogen gas)

Reactions (b) or (c) must take place in order to permit reaction (a) to proceed. Otherwise, the presence of the hydrogen film obstructs further progress of the primary reaction either by insulating the iron from the solution or by the increasing tendency of the hydrogen in the film as it is built up, to re-enter the solution and thus oppose the corrosion tendency.

In natural waters containing dissolved oxygen, reaction (b) is the controlling factor and corrosion is almost directly proportional to the oxygen content of the water.

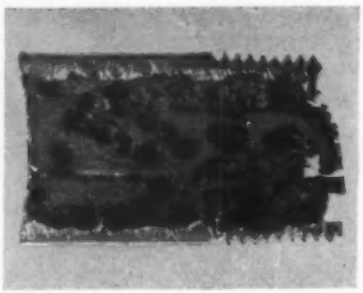


Figure 1 — Section of line showing pitting by dissolved oxygen.

The hydrogen ion in reaction (a) is available from ionization of water as follows:

(d) $2H_2O$ (water) $\rightleftarrows 2H^+$ (hydrogen ions) $+ 2OH^-$ (hydroxyl ions)

When hydrogen is plated out, the hydroxyl ions remaining cause an increase in the alkalinity adjacent to the point of corrosion. The ferrous ions entering solution will tend to precipitate as ferrous hydroxide. In the presence of dissolved oxygen, the ferrous ions will be oxidized to ferric hydroxide. Depending on the supply of oxygen, the resulting corrosion products will usually consist of black or green ferrous hydroxide next to the metal and reddish-brown ferric hydroxide which forms the outer layer, with graded mixtures of the two in between. The initial rate of corrosion is usually much greater than the rate after a longer period of time due to barriers set-up by the reaction products.

pH

At a pH below 4.3 (the region of free mineral acidity) the chief controlling factor in promoting corrosion is pH and the hydrogen film is removed by hydrogen evolution as shown by reaction (c). In the free mineral acid range the ferrous ions entering solution will remain soluble and therefore no insoluble reaction product will result. In the absence of a barrier the corrosion rate in acid solutions is therefore rapid. When the solution contains dissolved oxygen in addition to a pH value in the free mineral acid range, the rate of corrosion is further accelerated.

At a pH above approximately 9.5, as the alkalinity increases the pH or hydrogen ion activity decreases and the primary reaction as illustrated by equation (a) is slowed down. The rust coating formed in alkaline solutions is a more protective barrier than the one formed in neutral solutions. Therefore, the rate of corrosion is appreciably decreased and in fact in an alkaline solution, a negligible amount of corrosion will take place at normal temperatures and in the absence of dissolved oxygen. However, in the presence of dissolved oxygen, reaction (b) will still be controlling and while the rate of corrosion will be appreciably decreased a serious amount can still result.

At a pH between these limits (4.3—9.5) the presence of dissolved oxygen plays a more important role than the pH.

Dissolved Solids

In general, increase in dissolved solids content of a water increases the corrosivity. The electrolytic theory views the corrosion mechanism as an electrolytic cell. The iron metal provides both the anode and the cathode of the cell and the water is the electrolyte. At the anode,

the metal dissolves in the water, and in so doing it gives up two electrons which flow through the metal to the cathode where the electrons combine with the hydrogen ion to plate out hydrogen atoms as a film on the cathode. Various explanations have been advanced for the corrosive effect of higher dissolved solids. Higher dissolved solids increase the conductivity of the water thus favoring corrosion. One logical theory involves the effect of ions in destroying or altering the coating of corrosion products on the metal. A loose non-adherent coating under ordinary conditions may accelerate the rate of corrosion locally and produce a pitting condition, whereas a uniform, adherent coating may form an effective barrier and reduce the corrosion rate considerably. The chloride ion in particular exerts an adverse effect and within certain limits of concentration permits accelerated attack.

tact of dissimilar metals is known as galvanic action. The tendency of a metal to dissolve and enter solution as an ion is measured by the electrode potential between the metal and its ions. The listing of the electrode potential of the various metals constitutes the familiar

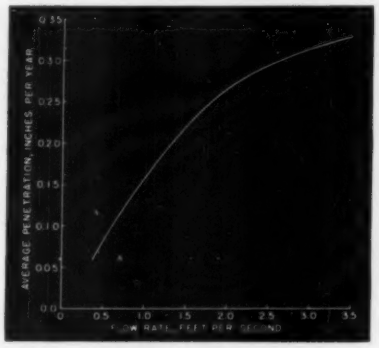


Figure 2—Influence of flow rate on corrosion.

ferrous bicarbonate, tends to elevate the pH and as the pH increases above 5.9, the reaction rate becomes reduced. The hydrogen formed in the reaction will also have a retarding effect particularly when the pH exceeds 5.9. The ferrous bicarbonate formed in the reaction is soluble and can be carried along with the condensate. When dissolved oxygen is also present, it will accelerate the rate of corrosion by removing the hydrogen to form water.

Other Factors

Corrosion of ferrous metals in the presence of moisture is a complex subject. Many other variables will affect the corrosion rate, such as homogeneity of the metal, condition of the metal surface, ratio of surface areas exposed by two dissimilar metals, static and cyclic stresses, oxygen concentration cells, etc.

INDUSTRIAL WATER SYSTEMS

Temperature

The chemical reactions of corrosion increase in rate with increase in temperature. Increased temperature decreases water viscosity and thus increases the diffusion rate of oxygen. Electrical conductivity is increased at higher temperatures, thus producing an effect similar to increase in dissolved solids. Pitting may be enhanced where adjacent metal areas vary in temperature, with the hotter sections anodic (more corrosive) to the colder areas.

Flow Rate

Increase in the rate of flow tends to increase the corrosion rate. Figure 2 illustrates data secured through the exposure of ¼" tubular low carbon steel specimens to Philadelphia (Delaware supply) tap water at a temperature of 120 F. The corrosion rate increases rapidly with increase in flow rate although at higher flow rates the influence is less pronounced. The influence of flow rate on corrosion is primarily due to the increase in supply of dissolved oxygen which destroys the hydrogen film in keeping with reaction (b).

Dissimilar Metals

The corrosion that occurs from the contact of dissimilar metals is known as galvanic action. The tendency of a metal to dissolve and enter solution as an ion is measured by the electrode potential between the metal and its ions. The listing of the electrode potential of the various metals constitutes the familiar Electromotive Series. The electrode potential of hydrogen is defined as zero. The metals that are higher in the series are considered able to displace those metals lower in the series.

The Electromotive Series cannot be taken as a precise indication of galvanic action. The potentials of various metals can be altered by ion concentration, temperature and the corrosive environment.

Carbon Dioxide

In a neutral water, taken from surface supplies where dissolved oxygen is present, the presence of carbon dioxide has little effect on the corrosion rate. However, many well waters, which are usually devoid of oxygen, will be found to contain appreciable amounts of carbon dioxide. In steam and condensate systems, it is possible to encounter serious corrosion from carbon dioxide even in the absence of dissolved oxygen.

When carbon dioxide dissolves in water it forms carbonic acid which is a weak acid and produces corrosion in keeping with the following reaction:

(a) $Fe + 2H_2CO_3 \rightarrow Fe(HCO_3)_2 + H_2$

iron — carbonic acid — ferrous bicarbonate — hydrogen

The above reaction proceeds rapidly at a pH below 5.9. The reaction product, ferrous bicarbonate, tends to elevate the pH and as the pH increases above 5.9, the reaction rate becomes reduced. The hydrogen formed in the reaction will also have a retarding effect particularly when the pH exceeds 5.9. The ferrous bicarbonate formed in the reaction is soluble and can be carried along with the condensate. When dissolved oxygen is also present, it will accelerate the rate of corrosion by removing the hydrogen to form water.

Water characteristics also are influenced by factors such as hydrogen sulfide, chlorine, and biological factors—all of which can accelerate markedly the corrosion rate.

Despite the complexity of the problem, great strides have been made in methods for control of corrosion. Continuing research by BETZ LABORATORIES has led to a better understanding of the effect of different variables, as well as provided increasingly effective control methods. A Betz Field Engineer will be happy to discuss your corrosion problem as it relates to any boiler, cooling or process water system.

No obligation, of course.

BETZ LABORATORIES, INC.
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■ CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

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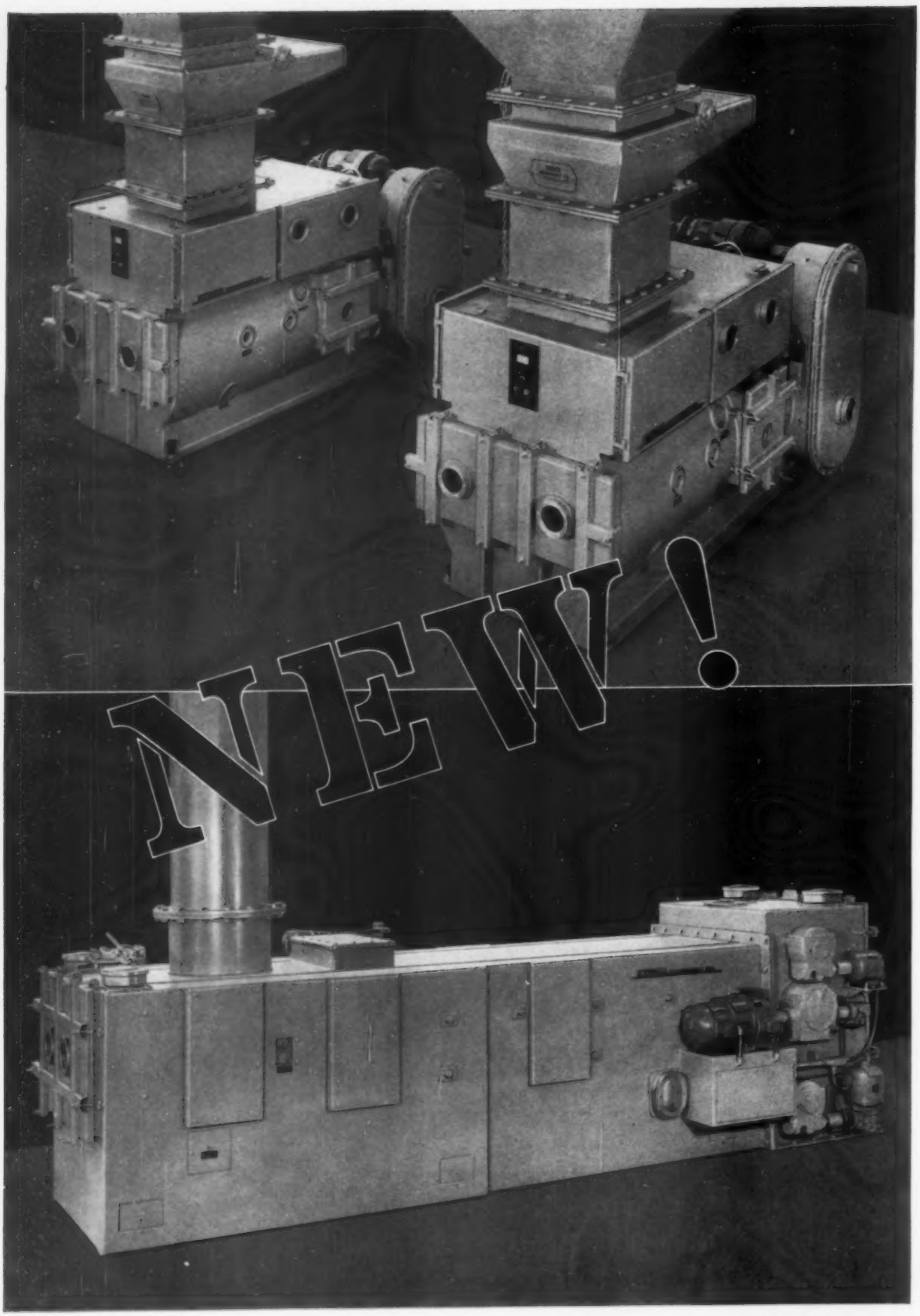
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To handle the increasingly higher pressures and temperatures required by modern industry, Powell has the finest selection of quality steel valves with many exclusive Powell features of superior design and construction.

Many of these Powell Valves are stocked for quick delivery. Contact your city's Powell Valve distributor. Or write directly to us. Our engineers will quickly solve your industry's flow control problems in handling water, oil, gas, air, steam, corrosive fluids.

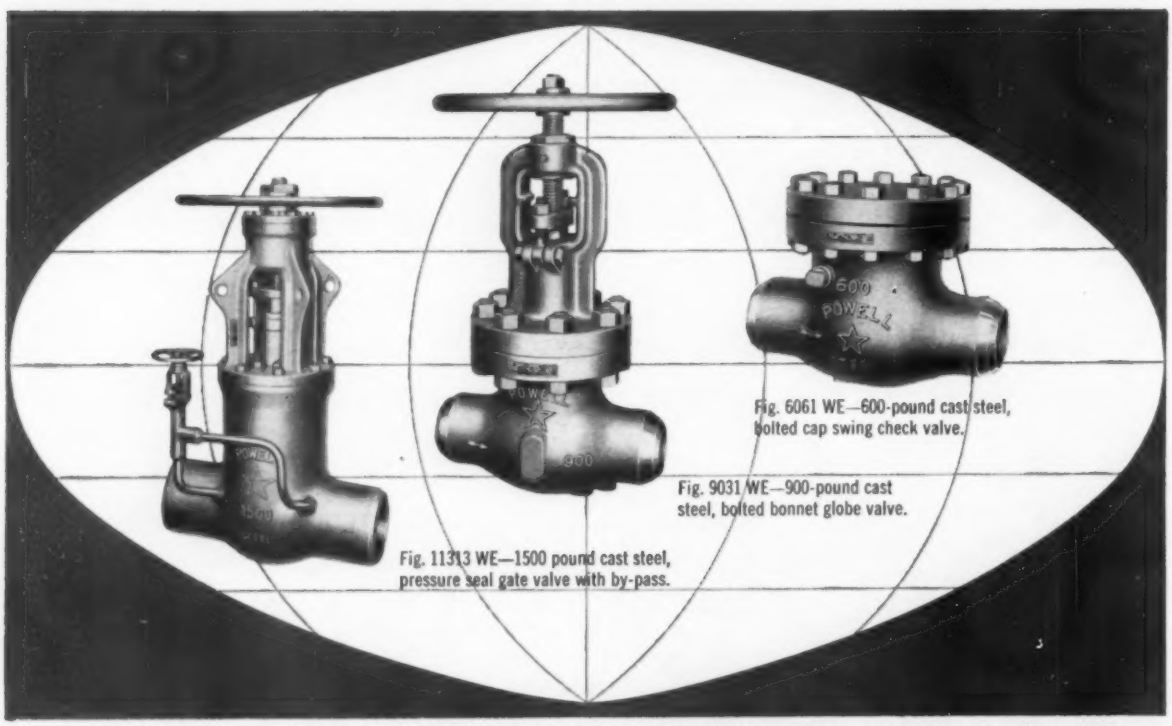

Fig. 6061 WE—600-pound cast steel, bolted cap swing check valve.

Fig. 9031 WE—900-pound cast steel, bolted bonnet globe valve.

Fig. 11313 WE—1500 pound cast steel, pressure seal gate valve with by-pass.

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HELPFUL BULLETINS

HOSE AND FITTINGS

101 Hose, Fittings, Couplings — Industrial Catalog 204, about 40 pp, contains information on hose, fittings, self sealing couplings and related products. Provides up-to-date specifications on products for general industrial applications, power plants, others. A hose selector chart is included, listing applications and fluids for which specific hose types are recommended. Instructions for ordering and assembling hose lines are also given. Arranged for easy selection, book is well indexed and illustrated. Aeroquip Corp.

102 Hose and Fittings — Comprehensive data on company's hose and hose assemblies, brass and steel tube fittings, hose and tube working tools, stock cabinets, hose racks and other specialty products are presented in 128-pp Catalog C-300. Profusely illustrated, it contains hose selector chart, assembly data chart, detailed specifications, technical data, application and installation instructions. Available to qualified power engineers, please state your title. The Weatherhead Co.

ELECTRICAL

103 Drip-Proof Motors — Bulletin 196 gives details on the Sterlicone Multi-Shielded drip-proof motor and illustrates design features. Explains how these motors can be used in many applications where adverse conditions of moisture, humidity, dust, oil and chemicals prevail. Sterling Electric Motors, Inc.

104 Electric Motor Controls — Contained in 72-pp Catalog 5900 are selector charts for magnetic and manual starters, giving horsepower, motor speed, heater size, heater ampere ratings, enclosure choices, along with style numbers and list prices. Covers manual starters, magnetic controls, drum controllers, pressure switches, various pilot devices and other motor control products and accessories. Furnas Electric Co.

105 Voltage Regulators — Distribution voltage regulator features designed to provide more economical and better voltage regulation are described in 16-pp Bulletin 21B7977E. Describes unit construction, electrical re-settable position indicator, quick-break mechanism, optimum system size, oil sight gage, locked control knobs, external by-pass arrester, operation counter, bearingless voltage regulating relay and others. Allis-Chalmers Mfg. Co.

106 Circuit Breakers — Six-pp Bulletin GEA-7070 describes a line of circuit breakers featuring symmetrical terminal construction with in-line mounting holes on the line and load ends. Provides selection, application, ordering information, illustrations and outline drawings. General Electric Co.

107 Electric Utility Instruments — Bulletin GEZ-2975 contains 12 pp of information on instruments for generating plants, distribution areas, load-dispatching offices, substations, and electrical testing. Contains selection data on units for specific applications. General Electric Co.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 105 and 106.

108 Tungar Bulb Data — Eight-pp Publication ETR-2091, a revised edition of company's manual on Tungar bulbs, contains typical circuits and operating data. Also provides descriptive and theoretical data on use of Tungar bulbs in rectifier circuits to provide noise-free power supplies with low voltage drop and high over-all efficiency. Electronic Components Div., General Electric Co.

109 Insulation Materials — Illustrated with both product and application pictures, and containing price information, 36-pp Catalog 34 presents electrical insulations for repair and maintenance of motors, generators, and electrical or electronic equipment. Covers packaged insulation products such as cuffed paper, formed fibre wedges, Mylar formed wedges, and hard maple wedges; cotton, asbestos, and woven glass tapes; cotton, glass and varnished or saturated tubing and sleeving; Mica plates and laminates; varnished fabrics; insulation papers; high temperature insulation materials for Class H units; baking and impregnating varnishes; pressure sensitive tapes. Insulation Manufacturers Corp.

110 Retractile Cords — Features and applications of company's line of coiled retractile cords are illustrated and described in 16-pp Catalog 582. Detailed selection tables included. Koiled Kords Inc.

PUMPS, COMPRESSORS

111 Free-Piston Pumps — Features and advantages of an air-operated free-piston pump designed to pump anything that flows are detailed in this product bulletin. Sequence diagrams showing operation included. The Crossley Machine Co.

112 Condensation Pumps — Twelve-pp Bulletin CP-600 illustrates and describes six basic condensation pumps designed for a variety of application requirements. Covers design features, general specifications, engineering data, dimension drawings, construction and operation details. American Air Filter Co., Inc.

113 Metering Pump — Bulletin 1153-C describes design features and operation of company's controlled volume metering pump with submerged liquid end. Detailed specifications and a capacity-pressure selection table included. Milton Roy Co.

114 Turbocharged Compressors — Features and advantages of company's turbocharged line of gas-engine-driven compressors are fully detailed in Bulletin 179. Cutaway view showing construction details is included, along with dimensions and specifications. Clark Bros. Co.

VALVES, PIPING, FITTINGS

115 Valves and Fittings — Twenty-pp Catalog R-7 contains detailed information on line valves, globe valves, relief valves, heat exchangers, check valves, SAE flare fittings and related brass products. Covers sizing and application of valves and components, with added data on working pressures and descriptions of codes and regulations to which products are manufactured. Superior Valve & Fittings Co.

116 Air Directional Valve — Detailed information on a line of air directional valves designed for a variety of installations is presented in this 16-pp bulletin. Includes dimensions, capacity, weight and other data, as well as diagrammatic views. Westinghouse Air Brake Co.

117 Compact Valves — Specifications and performance information on Trim Line valves designed for controlling small cylinders or operating diaphragms, pilot cylinders where mounting space is extremely limited are presented in 12-pp Bulletin 592. Illustrations of each of six valve actions are included. Hunt Valve Co.

118 Single Control Valve — Design and operating features of a single control valve for zeolite softeners, ion exchange units and filters are illustrated and described in Bulletin WC-122. Covers construction details of cast iron and all-plastic unit, includes schematic drawings of flow, and guide to valve selection for various corrosive and non-corrosive services. Graver Water Conditioning Co.

119 PVC Pipe Valves — Pertinent and detailed information on the use of PVC plastic pipe, fittings and valves is presented in this 36-pp handbook. Specification, design and installation data is included, as well as a comprehensive corrosion resistance comparison chart of seven types of plastic pipe carrying 162 chemicals. Kraloy Plastic Pipe Co., Inc.

120 Plastic Pipe — Sixteen-pp Technical Bulletin CE-80 describes characteristics and advantages of a general purpose rigid plastic pipe designed for processing, utilities and general industrial use. Chemical resistance tables and other technical data are included. American Hard Rubber Co., Div. Amerace Corp.

121 Pipe Alignment Guide — This bulletin introduces the Align-O Guide, for guiding of pipe lines which are expanding or contracting because of temperature changes. Explains how units permit movement of the pipe line in an axial direction only. Discusses necessity for pipe alignment guides, benefits afforded by Align-O Guides, how to use them. The Align-O Pipe Guide Co.

SAFETY, FIRE PROTECTION

123 Fire Alarm Systems — Publication 246 contains 36 pp of detailed information on fire alarm systems for critical applications in industrial, institutional and other public buildings. Contains typical

job specifications covering all systems. The Standard Electric Time Co.

124 Self-Sticking Identification — Products designed to aid in planning and executing industrial maintenance and safety identification programs are illustrated and described in 32-pp Catalog 520. Among items covered are piping marking systems, identification of plant wiring and electrical equipment, lubrication marking, marking for hazardous areas and equipment. W. H. Brady Co.

MECHANICAL POWER TRANSMISSION

125 Belt Drives — Precision constructed belts with gear-like teeth which engage mating grooves in pulleys are featured in 58-pp Catalog GB-201-A. In addition to specifications on Gearbelts and pulleys, catalog contains design and installation suggestions, engineering data and examples, combinations already worked out for convenient selection. Browning Mfg. Co.

126 V-Belt Drives — Illustrated and described in 36-pp Bulletin 9102 is a line of V-belt drives designed to utilize advantages of synthetic fibers and rubbers and high strength metals to achieve compactness, strength and economy. Includes drive selection tables, horsepower tables, nomograms for comparison of drive costs, sheave and belt specifications, bushing and keyseat specifications, and other data. T. B. Wood's Sons Co.

127 Flexible Couplings — Comprehensive selection data on flexible couplings is presented in 48-pp Engineering Catalog 60. Misalignment is described and basic coupling arrangements and load classifications are included, along with photos of couplings and installations, diagrams and tables. Thomas Flexible Coupling Co.

128 Eddy Current Coupling — Presented in 12-pp Bulletin GEA-6885 is extensive information on the Kinatrol line of eddy current coupling adjustable speed drives for 5 to 100 hp. Describes operating principle and contains data on torque capabilities, regulation and operation of entire package drive, cross-sections, dimension charts, and ratings. General Electric Co.

129 Spherical Roller Bearings — High capacity spherical roller bearings are described in detail in 52-pp Book 2760. Illustrated with numerous photos, drawings and diagrams, it includes comprehensive selection data and formulae, shaft bearing seat diameters, lubrication information, shaft details and bearing load ratings, diagrams, and charts. Link-Belt Co.

130 Spherical Roller Bearings — Features and advantages of company's spherical roller bearings with super-finished raceways and rollers for smoother operation are detailed in 16-pp Bulletin 113. Tables of bearing dimensions and load ratings are included. Hoover Ball and Bearing Co.

131 Pillow Blocks — Features and advantages of company's tapered roller bearing pillow blocks with unbreakable malleable housings are detailed in Bulletin Bu-102-A. Includes specifications and list prices, comparison chart for interchange with other makes, and load ratings table. Browning Mfg. Co.

INSTRUMENTS AND CONTROLS

132 Industrial Controls — This 88-pp catalog presents comprehensive information on company's industrial controls, including automatic temperature, pressure, level and flow controls, as well as counters, switches and automation controls. Other items illustrated and described are industrial actuators, combustion instrument controls, controller indicators and pressure indicators. General Controls Co.

133 Automatic Controls — Comprehensive data on mercury switch equipped controls for single stage pressure, two-stage pressure, differential pressure, single-stage temperature, two-stage temperature, liquid level and mechanical movement are presented in 56-pp Catalog 860. Each control with accompanying description, specifications and engineering data is indexed by product name and type number. The Mercoid Corp.

134 Remote Control Systems — This 12-pp catalog illustrates and describes mechanical remote control systems for the nuclear industry. Illustrates a typical control system, including remote positioning of elements, control rod drive, charge seating mechanism, remote butterfly valve operator, activation wire drive system, traversing signal drive, and neutron source drive. Teleflex Inc.

135 Recorders, Control Stations — Specifications FS301-8 describes recorders and recording control stations which continuously indicate and record the standard 4-20 ma d-c output of any ElectriK Tel-O-Set transmitter or transducer. Specifications, dimensions and features are covered Minneapolis-Honeywell Regulator Co.

136 Temperature Controls — Filled with charts, drawings, and diagrams, 24-pp Bulletin 101 discusses industrial temperature measurement and control, including ways of responding to temperature, ways of putting temperature response to work, mercury-bulb instrumentation, basic types of controls, and a score sheet for the mercury-bulb system. Also covers basic concepts of electrical, pneumatic and mechanical controls. The Partlow Corp.

137 Industrial Thermometers — Bulletin F-2 illustrates and describes a line of industrial thermometers in air duct and moisture-proof models, and a specially easily positioned model that adjusts and locks in any required form or angle to bypass piping for better visibility. Precision Thermometer & Instrument Co.

138 Rotameters, Flow Indicators — Condensed Bulletin M-1 features precision instruments for measuring, indicating, recording and controlling rate of flow of all types of fluids. Various rotameters are illustrated and described, as well as flow indicators for installation in pipe lines where it is necessary to determine, by visual observation, that fluid is flowing in right direction and in proper state and condition. Schutte and Koerting Co.

139 Rotameter Selector — Bulletin 110 illustrates and describes a complete line of rotameters and accessories for flow instrumentation. Details advantages of variable area flow meters and displays the various types of meters in their specific applications. Brooks Rotameter Co.

140 Rugged Rotameters — Bulletin 150 gives details of materials used in manufacturing rotameters for corrosive applications. Various types of field-tested meter designs are illustrated and described in detail. Brooks Rotameter Co.

141 Thermocouple Wells — Detailed selection data on thermocouple wells and assemblies for a variety of applications are presented in 18-pp Catalog G102-1. It includes such information as well designs and dimensions, pressure and temperature ratings, corrosion data, thermocouple assembly data, and ordering and pricing information. Minneapolis-Honeywell Regulator Co.

142 Probes and Accessories — Technical Bulletin RF-5914 contains data on a line of probes and accessories for capacitance-type level control instruments. Various types of standard probes designed to meet requirements of most applications are illustrated and described. Robertshaw-Fulton Controls Co.

143 Explosion-Proof Controls — Advantages of company's explosion-proof controls, indicating, non-indicating and recording, are detailed in this product bulletin. Design features and ratings are listed. The Partlow Corp.

144 Air Meters — Catalog 170 describes a line of air velocity, flow, pressure and vacuum measuring instruments operating on company's compensated thermopile principle. Basic circuit of compensated thermopile shown. Hastings-Raydist, Inc.

145 Speed Recorder — Bulletin GET-2741-3A discusses application, features, principles of operation and specifications of company's multi-range strip-chart speed recorders. Material-processing applications related to the paper, steel, textile, rubber, and other industries are described, and application diagrams and schematic of recorder included. General Electric Co.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the Reader Service Card on page 105. When ordering catalogs, allow time for us to relay your requests to the manufacturers — and for them to mail out copies. Remember, manufacturers are often swamped with catalog requests.

146 Leak Detector — Six-pp Bulletin GET-2936 gives detailed instructions on use of halogen leak detectors for finding leaks in enclosures that can be pressurized, in such applications as steam boilers, valves, piping, transformers, air-conditioning and refrigeration equipment, and others. Includes discussion of system preparation, testing procedures, quantitative measurement techniques, and calibration. General Electric Co.

147 Servo System Simulator — Servo Design Report SDH-2, 6 pp, explains application of the Servolab, a servo system simulator, to design of control systems for industrial process controls, others. Equipped with a block schematic, screwdriver and Servolab, you can simulate complete or partial servo loops, without programming or fabrication of intermediate prototypes. Illustrations show the

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For boiler pressures up to 1050 psig.
Vision length—5 port—12⅜" and 7 port—18". Longer vision lengths easily obtained by adding 18" or 12⅜" sections for necessary length.

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GAUGE NEVER REMOVED FROM BOILER FOR GASKET CHANGES OR OTHER NORMAL MAINTENANCE

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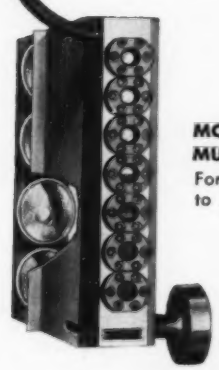

MODEL MP-3000 MULTI-PORT
For boiler pressures up to 3000 psig.

Note These Features:

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- **Thermal Stability — Warm-up in minutes instead of hours.**
- **Ports are 1⅛" diameter on MP 1050 Gauge.**
- **Gauge body machined from a solid block of stainless steel. Welded tube and flange connections.**
- **"Hi-Lite" Illuminator — More visibility with less cleaning.**

The individual glass disks provide inherent thermal stability not obtained in the continuous vision gauge which requires the long glass and mica. Thermal stress is much less troublesome and damaging. Small mica disks cost less, and are not subject to wrinkling or cracking. Any port — glass, gasket and mica — may be replaced in minutes without removing the gauge from the boiler. Torquing operations are much less critical, and warm-up period is minutes instead of hours.

The Bi-Color feature makes reading sure. By an invariable optical principle, steam always shows red, water green. Changes in level show instantly.

8302

For a trouble-free gauge that makes reading of water level sure and easy — Diamond Multi-Port Bi-Color —

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Bulletin 2044-A for pressures up to 1050 psig
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ROTO Hand-hole Seat Scraper

Roto Hand-hole Seat Scraper for B & W Boiler.

Eliminates tedious labor

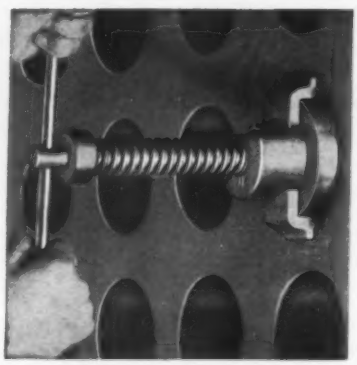
Assures clean, tight fit

Roto Hand-hole Seat Scraper makes short work of cleaning dirty hand-hole seats. This simple, hand-operated tool has adjustable, spring-mounted retractable knives. A few turns to the right remove foreign matter without cutting the metal. A half turn to the left releases the tool, and the job is done. Customers say that the Roto Seat Scraper does the job up to 12 times faster than by any other method. Try one and you'll wonder how you ever got along without it. *Send for details.*

Now available

for most hand-hole shapes and sizes

Standard Roto Seat Scrapers are available for the following equipment. Special types made to order.



Illustrating ease of operation of Roto Hand-hole Seat Scraper.

Type of Boiler	Opening	Tube Size
Babcock & Wilcox # 4	Round	2"
" " " #41	Oval	2"
" " " #70	Round	3"
" " " #48	Oval	3½"
" " " #40	Oval	3¼"
" " " #24	Oval	4"
" " "	Oblong	4"
Bros	Round	3¼"
Casey Hedges	Oval	3½"
" "	Oval	4"
Combustion Eng'rg	Round	3"
" "	Oval	3"
Edgemoor	Oval	4"
Erie City	Ellip	2½"
" "	Oblong	3¼"
" "	Ellip	3¼"
" "	Pear	4"
Foster Wheeler	Oblong	2½"
" "	Oblong	3"
" "	Ellip	4"
Geary	Oblong	4"

Type of Boiler	Opening	Tube Size
Heine	Round	3½"
"	Oval	3½"
International Boiler 2	Oblong	3"
Keeler	Round	3½"
"	Round	4"
"	Diamond	3½"
"	Diamond	4"
Lasker	Oblong	
Murray	Oval	3½"
"	Oblong	4"
Oil City	Oval	3½"
" "	Oblong	4"
Riley Stoker	Ellip	3¼"
Springfield	Ellip	3¼"
Union Iron Works	Pear	4"
Henry Vogt	Ellip	3¼"
" "	Oval	4"
Walsh & Weidner	Oval	4"
Wickes	Ellip	2½"
"	Ellip	3¼"
"	Pear	4"
"	Round	4"

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Servolab packaged assembly of electronic and electrochemical components, and text tells how this versatile synthesis and analysis system solves complex servo problems quickly. Servo Corp. of America.

148 Industrial Waste Treatment — Bulletin B97-2, 24 pp, is a compilation of articles on instrumentation for treatment of industrial wastes. Illustrates and describes case histories of how instruments are applied to industrial waste treatment systems to prevent stream pollution. Minneapolis-Honeywell Regulator Co.

149 Data Collecting System — This 18-pp booklet describes the Friden Colectadata, a data collecting system which automatically channels information from numerous work stations to a central processing point. Covers equipment involved, applications for the system, benefits. Systems diagram included. Friden, Inc.

PROCESSING EQUIPMENT

150 Vacuum Filters — Two vacuum filter styles for efficient filtration of industrial process water where a highly polished water is required are featured in Bulletin Ref. No. 1860.20-2. Illustrates flat-leaf style and concentric-leaf filter element style, and includes cutaway views, dimensional drawings, and capacity charts. Proportioneers Div., B-I-F Industries, Inc.

151 For Process Industries — Twelve-pp Bulletin G-3C discusses applications and performance characteristics of pumps, pneumatic conveyors, fluidizing conveyors, rotary compressors and vacuum pumps, horizontal-grate coolers, suspension-type preheaters, positive pressure blowers and gas pumps, and induced draft fans. Operating principles are explained and photos show typical installations. Dimensions and capacities listed. Fuller Co.

HEATING, COOLING

152 For Heating or Processing — Detailed information on company's packaged boilers for heating or processing is presented in 8-pp Bulletin AD-137. Contains specifications, ratings and dimensions, cutaway sections showing four-pass gas travel and water circulation flow, sketches of recommended boiler room layout. Cleaver-Brooks Co.

153 Heat Exchangers — Shell and tube heat exchangers, including copper base alloy, steel and stainless steel fixed tube bundle heat exchangers, are illustrated and described in 16-pp Catalog 1258A. Includes tables of pressure ratings and material specifications for steam service heat exchangers, selection data, oil viscosity graph, tables of weights and dimensions. The Young Radiator Co.

154 Duplex Tubes — Advantages of company's duplex condenser and heat exchanger tubes available in a variety of alloys and alloy combinations for maximum corrosion control are detailed in this product bulletin. Table lists typical applications, media handled and recommended tube for this application. Bridgeport Brass Co.

155 Coil Selection Guide — Information on water and direct expansion refrigerant coils is given in 28-pp Catalog 5559. Provides selection data on water heating and cooling coils; physical and performance charts: mean effective temperature difference charts. Explains determination of final dry bulb temperature

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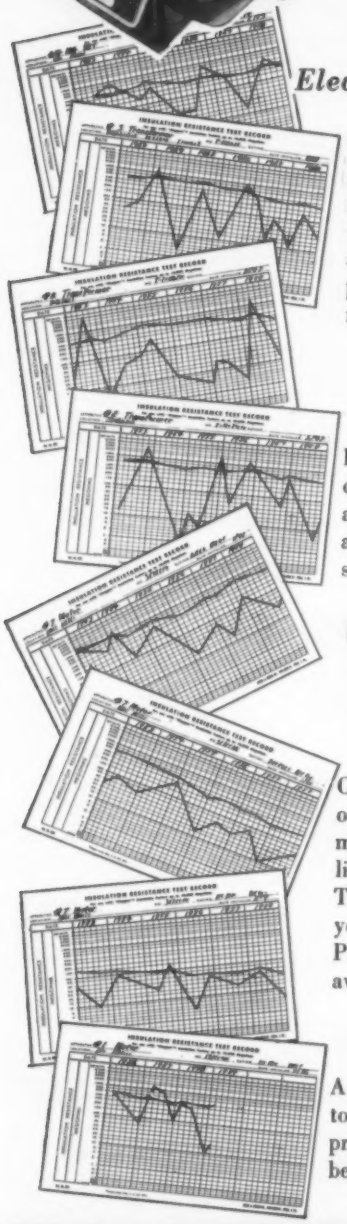
Electrical Operations Everywhere



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and direct expansion coil surface temperatures. Also includes direct expansion cooling coil capacity tables, psychrometric chart, total heat table, dimensions, piping diagrams, architectural and engineering specifications. Young Radiator Co.

OTHER EQUIPMENT

156 Air-Hydraulic Boosters — Engineering Bulletin B-200P shows how to convert shop air into intensified (up to 10,000 psi and over) hydraulic pressures for operating hydraulic cylinders and other hydraulically operated devices. Contains pricing, mountings and dimensional data on models and sizes. Explains when boosters should be used in place of pumps and large bore air cylinders. Includes information on field applications, method of calculating boosters, circuits demonstrating operation of the booster air-oil circuit in its low pressure approach stroke, high pressure working stroke, return stroke phases, and air savings possible. Miller Fluid Power Div., Flick-Reedy Corp.

157 Hinged Closures — One-man hinged closures with built-in safety features for vacuum, low and high pressure service are described in this product bulletin. Photos illustrate features, charts give dimensional specifications and cross-sectional drawings show design details. Tube Turns Div., Chemetron Corp.

158 Tractors for Grounds Maintenance — Versatility of company's tractors and equipment for roadside and grounds mowing and mulching, street and parking lot cleaning and snow removal, landscaping, and other maintenance jobs is illustrated in this full-color 8-pp bulletin. Tractor and Implement Div., Ford Motor Co.

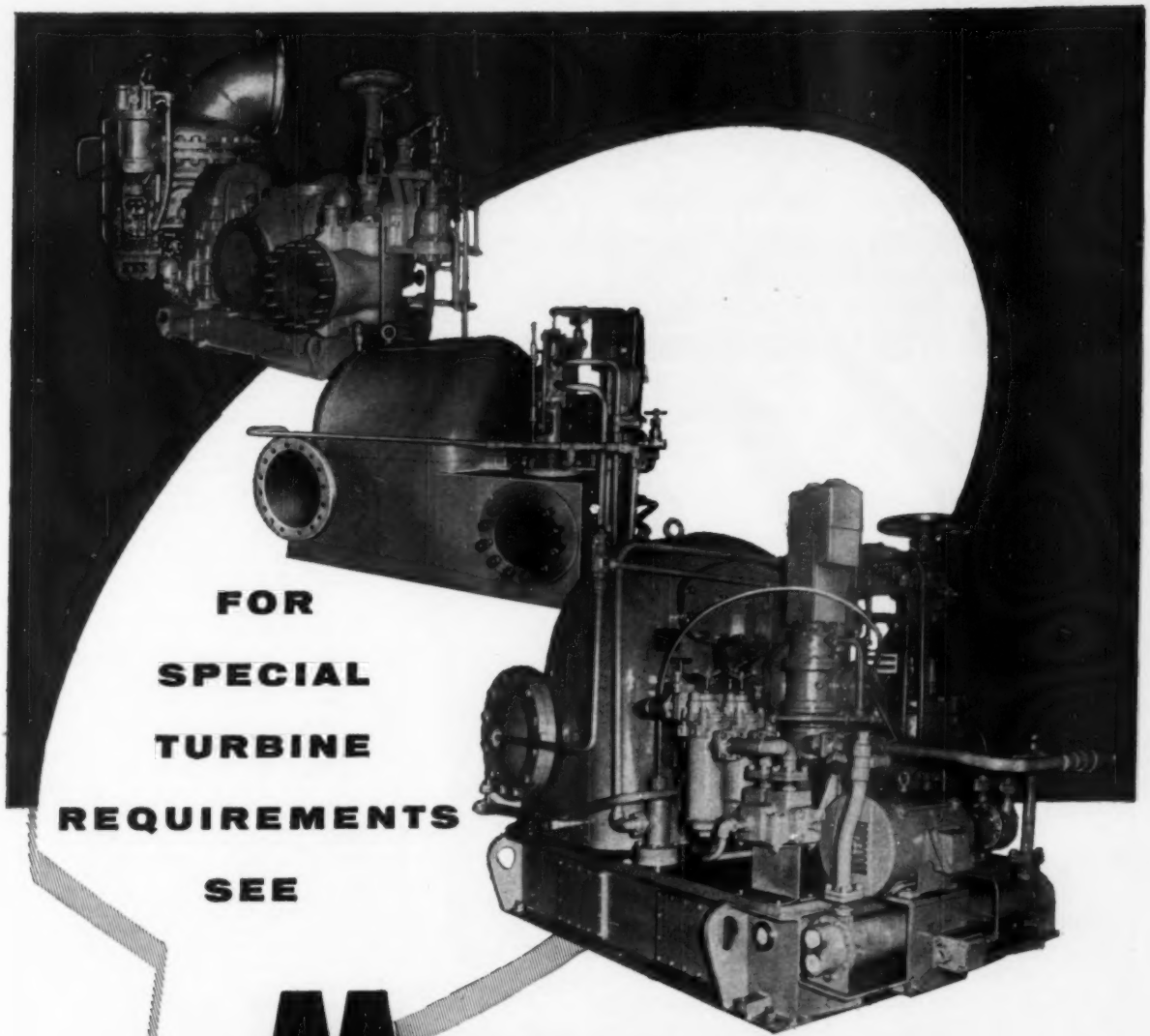
159 Gravimetric Feeder — Theory of design and operation of gravimetric feeders is detailed in this 8-pp bulletin, Form 157. Advantages of feeding by weight are noted, and photos, drawings, and diagrams showing component features included. Stock Equipment Co.

160 Non-Shrink Grouting — Sixteen-pp Bulletin E-1d explains how to overcome grout failure due to shrinkage, through use of properly applied non-shrink grout. Outlines and illustrates common methods of grouting different types of equipment, the mixing and placing of grout and cold and hot weather grouting. The Masters Builders Co.

161 On Boiler Gasket Leakage — Some causes of boiler gasket leakage are discussed in Technical Paper 139. Factors to consider in overcoming or minimizing gasket leakage, such as selection of gasket joint, installation, and corrosion protection, are explained. Betz Laboratories, Inc.

162 Ferrous Metallurgy — "Basic Guide to Ferrous Metallurgy" is a four-color chart showing principle characteristics of steels (with carbon content ranging to 0.9 per cent) across the temperature range to 1900 F. Important working zones, including preheating for welding, stress relieving, normalizing, annealing, carburizing and forging are shown. Tempil Corp.

163 Unit Air Filters — Construction and application of permanent washable unit air filters is fully detailed in 12-pp Bulletin 207. Covers filter maintenance methods and equipment, installation data, and includes charts, arrestance-resistance



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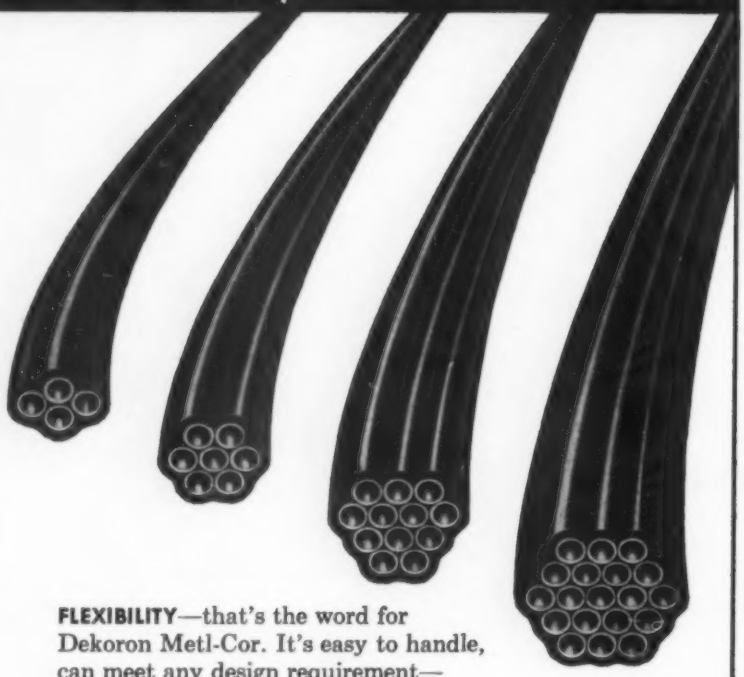
cuts installation costs

bends without distortion

solves instrument line corrosion problems



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SECOND, the Metl-Cor design is flexible. You can specify Metl-Cor with core tubes in either copper or aluminum . . . in any standard or special OD or wall thickness . . . with almost any number of tubes in each bundle.

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curves, engineering data, dimension drawings. American Air Filter Co., Inc.

164 Products for Tooling — Plastic Steel and other products for making tools, jigs, fixtures, metal forming dies, molds, and masters for duplicating are described in 8-pp Bulletin 2. Typical applications are illustrated and described in case-history form. Devcon Corp.

165 Plant Layout Models — This 12-pp Bulletin describes applications and savings that can be realized from use of models in plant layout work. All phases of the model design and construction are shown, including how to estimate cost of model. Visual Plant Layouts, Inc.

166 Welding Electrodes — Eight-pp Bulletin A-1 describes successful applications of welding electrodes and wires in a variety of industries. Performance results and economies detailed. The McKay Co.

167 Floor Coating Systems — Chart 10 for protective coating system shows, by columns, the resistance of each system to chemicals, thermal shock, abrasion and temperature. It also gives compressive strength, impact resistance, skid proof properties. Carboline Co.

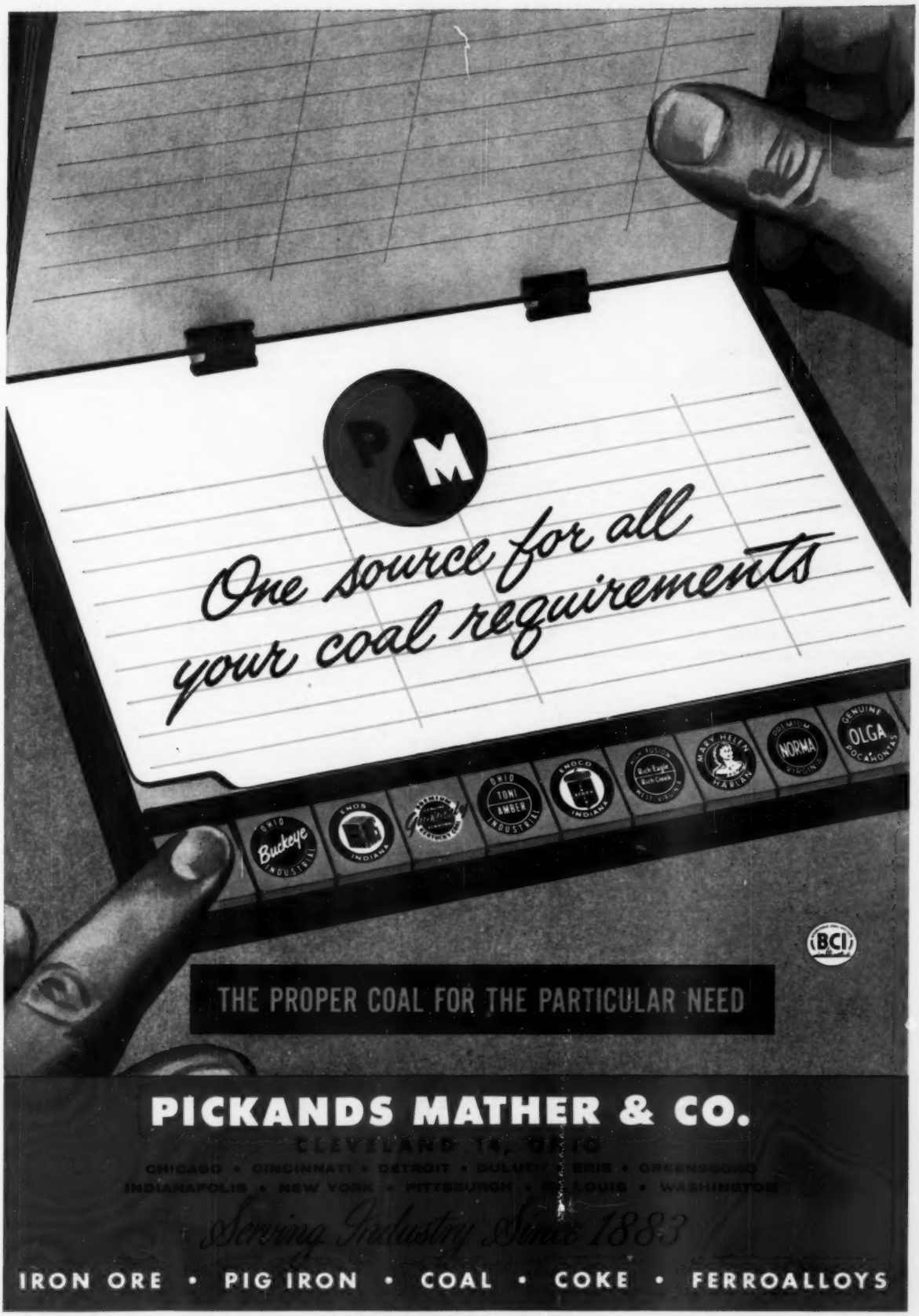
You'll save time in ordering bulletins by using the Reader Service Cards on page 105. Of course we honor letterhead requests — but it takes us somewhat longer to handle them.

168 Corrosion Resistance Chart — Over 150 chemicals and their recommended usage with ductile iron, iron, steel, 316 and 304 stainless steel, Monel, brass, bronze, copper, aluminum and plastisol plastic are listed in Corrosion Resistance Chart J-CRC. Shows which gasket materials are needed for various chemicals when Kamlok couplers are used and which O-ring materials are needed when swivel joints are used. OPW-Jordan Corp.

169 For Teaching Servosystems — A new method of techning servo systems that bridges the gap between theory and practice is described in 8-pp Special Report SR-3. Explains how packaged assembly of electronic and electrochemical components permits students to build and test servo systems, demonstrates formula derivation, characteristics of control systems and feedback loops. Servo Corp. of America.

170 Hand Torches — Illustrated and described in 36-pp Catalog 818 is a line of gas welding and cutting hand torches, outfits, tips and accessories. General descriptions of various types of welding and cutting torches are included, with data on features and detailed specifications, and welding and cutting tips for general purpose and special gas welding and cutting. Air Reduction Sales Co., Div. Air Reduction Co., Inc.

171 Vibrating Feeders — Featured in 12-pp Book 2869 is a line of vibrating feeders designed for feeding a wide range of bulk materials at a uniform rate from bins, hoppers, storage piles or conveyors. Selection and application data on all size ranges, and illustrations of single and twin motor types, floor mounted or cable suspended included. Link-Belt Co.



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Steam trap dependability is a matter of what the manufacturer puts into the trap

ARMSTRONG TRAPS ARE DESIGNED AND MADE TO GIVE YOU DEPENDABILITY

1. Efficient, proved operating principle

Armstrong Traps provide the most advanced development of the time-proven inverted bucket principle. Simple, but effective, there isn't much that can go wrong.

2. Good design

Armstrong Trap design gives big capacity in a small package. The mechanism is virtually fool-proof. All body styles are easy to inspect and maintain without removal from the line.

3. Highest quality materials of construction

Only the best goes into Armstrong Traps. Bodies are close grained 30,000 tensile iron castings or high quality forgings. Working parts are all tough, corrosion resistant stainless steel.

4. Good workmanship

Armstrong Traps are made by craftsmen who take pride in their work. Careful inspection and frequent checking insure the quality of the trap.

5. Application know-how

Your problem has probably been solved already in the extensive experience of the Armstrong engineering and sales organization. You can be sure of sound, dependable recommendations.

Your local Armstrong Representative can show you what Armstrong dependability can do for you. Call him today or write direct.

860 Series for low pressure heating service.

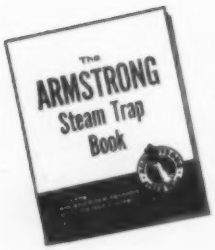
800 Series, side inlet, side outlet.

No. 801, side inlet, bottom outlet.

880 Series, integral strainer.

200 Series, bottom inlet, top outlet.

Forged Steel Series for high pressures, high temperatures.



The 48 page Armstrong Steam Trap Book tells how to correctly size, install and maintain steam traps for any pressure, any temperature, any load plus full catalog data on Armstrong Steam Traps. Ask for Catalog K.

ARMSTRONG MACHINE WORKS

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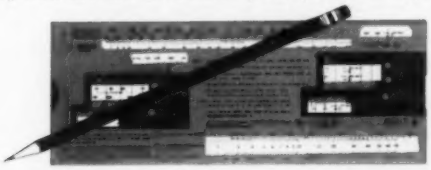
Handy new Morton Calculator gives you data at your fingertips when planning or improving hard water treatment systems.



With this amazing new calculator you can accurately determine for yourself the requirements of a water softening installation. You can quickly figure: the conversion of p.p.m. water hardness to grains per gallon hardness; the amount of exchange resin; the brine and salt requirements for maximum efficiency; and brine tank size and operating brine level adjustments.

You can make daily use of the calculator in selecting tank sizes for liquid volume problems.

This Morton Ion Exchange Calculator comes to you free of charge—as do all the services of Morton's Brine Engineers, who will work readily with you on water softening problems. Their experience and service can save you time, money and labor in the planning or improvement of your water treatment system. Morton technical assistance will assure your system of maximum operating efficiency and the latest labor-saving techniques.

Mail coupon today for your free Morton Ion Exchange Calculator, and, if you wish, you also may ask for information about Morton's Brine Engineering Services.

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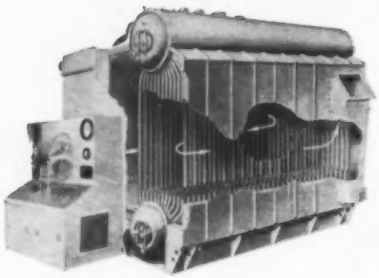
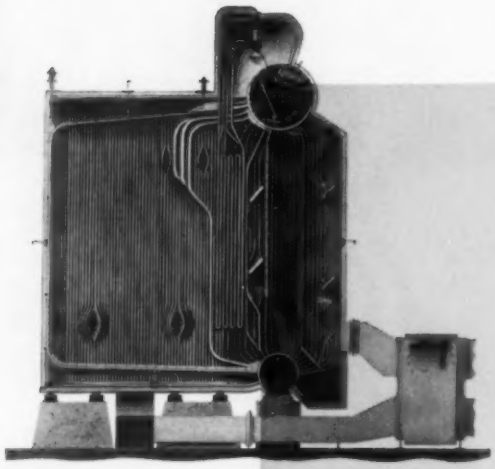
OIL AND GAS FIRED BOILERS
(standardized designs)



C-E Shop Assembled Boiler, Type VP—Available in 23 sizes ranging from 4000 to 90,000 lb of steam per hr capacity . . . pressures to 700 psi. Available with integral console control panel. This unit contains more water-cooled area per cubic foot of furnace volume than any other boiler of its size and type.



C-E Vertical-Unit Boiler, Type VU-55—Available in five sizes . . . capacities from 70,000 to 150,000 lb of steam per hr . . . designed for three pressures 250, 500 and 700 psi, and total steam temperatures up to 800 F. Equipped with tangential burners, 60-inch steam drum. Tangent tube waterwalls offer complete furnace protection, minimizing maintenance.

MODERN INDUSTRIAL

Advanced designs for any fuel, firing or capacity needs

All the designs pictured here have something in common. All are evolved from a basic design concept—a 2-drum, vertical boiler with fully water-cooled furnace in front of the boiler proper — a design which Combustion Engineering originated more than 30 years ago and which has enjoyed the widest acceptance.

All are fully integrated designs comprising boiler, furnace, fuel-burning and, where required, superheat and heat-recovery equipment, coordinated into a smoothly functioning unit.

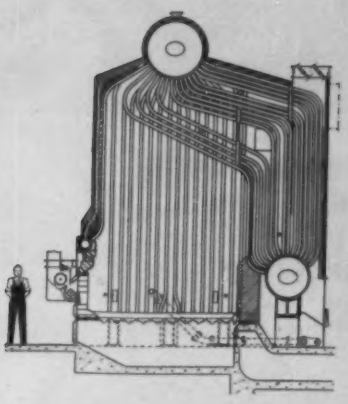
All have benefited from C-E's experience in meeting the most exacting standards in steam generation—the standards of the electric utility industry for which C-E has designed and built many of the boilers which are regarded as milestones in the industry's progress toward ever higher efficiency and economy.

All have demonstrated — in many installations — high standards of performance . . . economy, reliability and suitability for the particular fuel and operating conditions for which they were selected.

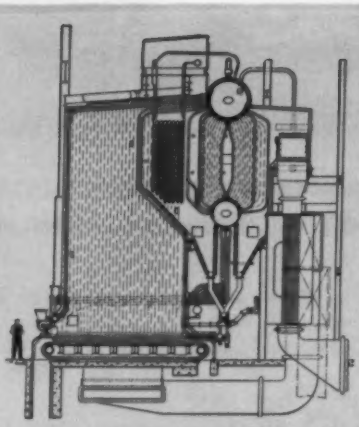
So — no matter what combination of conditions prevail at your plant, Combustion Engineering has a boiler unit that can meet your requirement, exactly — and economically. We'd like to discuss it with you and your consultants at your convenience.

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;

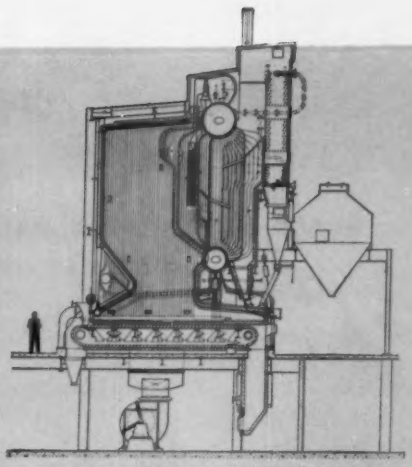
STOKER-FIRED BOILERS



C-E Vertical-Unit Boiler, Type VU-10 — fired by a Spreader Stoker. VU-10 Boilers are available for capacities from 10,000 to 60,000 lb of steam per hr with pressures to 475 psi; superheat to 150 F. Can be equipped with Underfeed or Traveling Grate Stokers if desired.



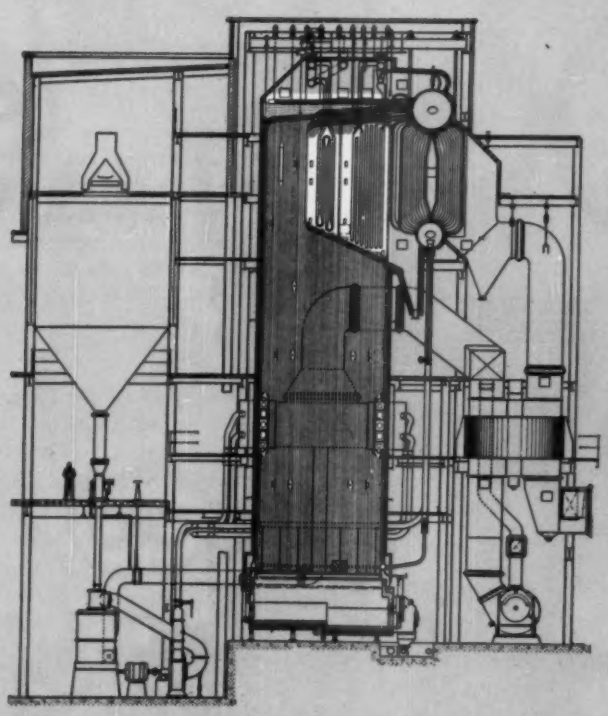
C-E Vertical-Unit Boiler, Type VU-40 — fired by Spreader Stoker, continuous discharge type — A baffleless boiler with capacities ranging up to about 300,000 lb of steam per hr, with pressures to 1,200 psi; temperatures to 950 F.



C-E Vertical-Unit Boiler, Type VU-50 — fired by Traveling Grate Stoker — Units of this design are suitable for capacities up to about 150,000 lb of steam per hr; pressures to 1,200 psi; temperatures to 950 F.

BOILERS

PULVERIZED COAL FIRED BOILERS



C-E Vertical-Unit Boiler, Type VU-40 — using C-E Raymond Bowl Mills and tilting, tangential burners — capacities up to about 600,000 lb of steam per hr, pressures to 1,200 psi, temperatures to 950 F.

Note: The drawings on this page are a few examples of the many units available for coal firing: all are readily adaptable to oil or gas firing.

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C-255

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accuracy, reliability
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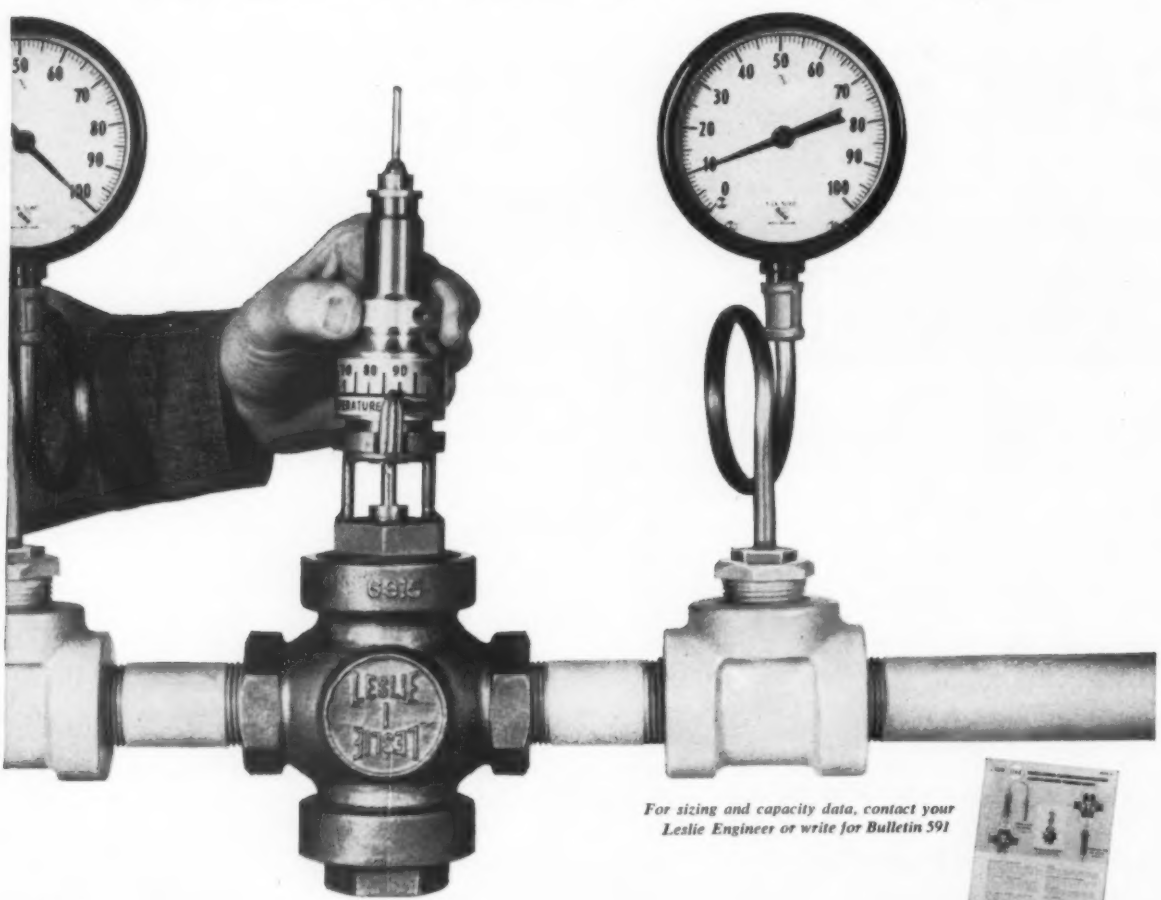
NEW SINGLE-SEATED, BALANCED DISC, TEMPERATURE REGULATOR HANDLES INLET PRESSURES TO 100 psi.

New Leslie regulator can handle inlet pressure and pressure drops to 100 psi. High power, positive movement of an actuating bellows with solid liquid fill, and the virtually friction-less stuffing box provides stem movement exactly proportional to the temperature change at the bulb.

Designed for steam or water service, it features a single seated, self-aligning, tight closing inner valve. (Units can be changed in the field from direct to reverse acting, or from reverse to direct acting, simply by inverting body and main valve.)

Applications include instantaneous heaters or coolers—shell and tube or shell and coil heat exchangers; storage or tank heaters; and, process heaters or coolers of all types. Available in cast iron or cast bronze bodies for temperatures to 450°F. Sizes ¾ and 1", screwed connections.

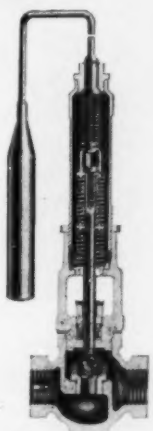


For sizing and capacity data, contact your Leslie Engineer or write for Bulletin 591

LC-10

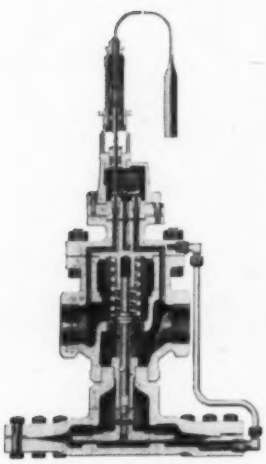
LINE OF TEMPERATURE REGULATORS.

OTHER VERSATILE LESLIE REGULATORS PROVIDE PRECISE TEMPERATURE AND PRESSURE CONTROL.



Bellows Operated Temperature Regulator For Small Flows

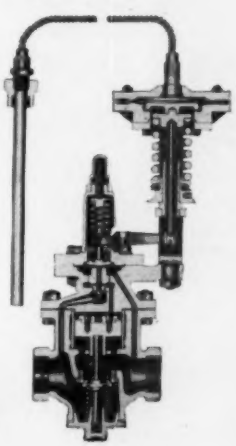
Direct Operated Design is used for small flow heating and cooling service, size ⅜, ½ and ¾". Liquid filled thermostatic element supplies ample power to stroke the single seated main valve. Valve travel is directly proportional to temperature change at bulb. This design is suitable for instantaneous and storage type heaters. It is also available in double seated construction for cooling service.



Class TKM Pilot Actuated, Metal Diaphragm Operated Temperature Regulator

Pilot Operated, Single Element Control also uses the liquid filled element to operate pilot device which applies operating pressure from the regulator inlet to a diaphragm for stroking main valve in heating or cooling service. Large diaphragm area and operating pressure supply ample power for controlling long stroke, single seated main valve with full flow capacity in sizes ½-4". Regulator has a 3 to 5° throttling range and is suitable for all storage type heat exchangers and for any system requiring on-off control.

Class LTCO Pilot Actuated, Piston Operated Temperature Regulator



Pilot Operated, Duo-Matic (two-element control) design offers both temperature and pressure regulating functions in a pilot actuated, piston or diaphragm operated regulator. The valves can handle a range of inlet steam pressures in heating services from 25 to 600 psi and controlled pressure ranges of either 2 to 15 psi or 10 to 250 psi. These characteristics are ideal for all storage type heaters and most instantaneous heater problems. Available in sizes ¼-6" with iron, bronze and cast steel construction.

For complete sizing and capacity data, write for Bulletin 5307-A.

TRADE LESLIE MARK

REGULATORS and CONTROLLERS

Leslie Co., K30 Grant Ave., Lyndhurst, New Jersey

Over 275 Factory-Trained Engineers At Your Service—Nationwide!

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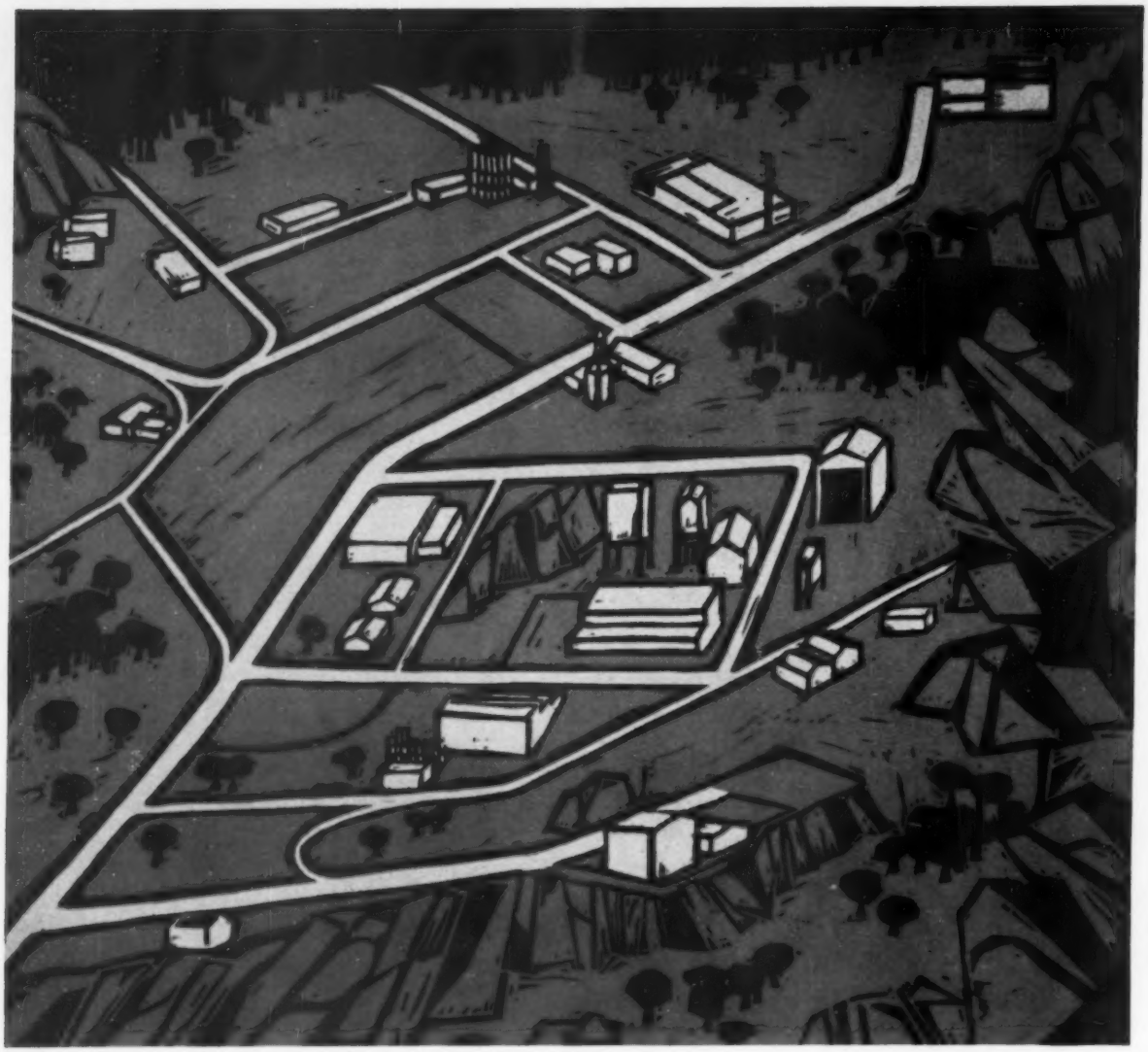

AI's extensive field laboratory is located in California's Santa Susana Mountains. *Woodcut by Edward Kysar.*

How can A.I. facilities help you plan a Nuclear Program?

In the picturesque Santa Susana mountains near Los Angeles, Atomics International has built an extensive field laboratory for research, engineering and testing in the nuclear sciences. Here, and at a headquarters complex in the valley below, men who pioneered the creative uses of atomic energy are applying their experience to develop advanced nuclear reactors and associated equipment.

Fourteen years of experience in developing various types of reactors for the Atomic Energy Commission and other organizations have given the men of Atomics International a collective background unparalleled in the industry. The facilities at their disposal are among the most sophisticated and extensive in the world.

Results of AI's work have been demonstrated in projects for the AEC which include the Organic Moderated Reactor Experiment at the National Reactor Testing Station in Idaho and the Sodium Reactor Experiment at the company's field laboratory. Additionally, AI built and is operating SNAP II, a 220 pound prototype reactor to produce three kilowatts of electricity for space vehicles.

Atomics International is also building large power reactors for electric utilities in Ohio and Nebraska under AEC programs. Studies are underway for other power reactors in the United States and Europe. Research reactors have been built by AI for Denmark, Germany, Italy, Japan, Puerto Rico and several sites in the United States.

For details contact: ATOMICS INTERNATIONAL, Canoga Park, California, U.S.A. Cable address: ATOMICS.

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Power Engineering

ATOMICS

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A POWER ENGINEERING FEATURE FOR UTILITY & MAJOR INDUSTRIAL EXECUTIVES

A. W. Kramer, Editor

A Periodic Report on Atomic Energy Development Throughout the World
Published by Technical Publishing Co.

March 1960

New Names, New Elements, New Properties. The Periodic Table of the Chemical Elements which hangs in my office is a varicolored affair with all sorts of curious symbols and many strange names. There are, for example, Praseodymium, Gadolinium, Dysprosium, Erbium, Berkelium, Californium, Nobelium, and one, Mendelevium. The latter name is of interest not only because it is the second to the last on the chart but because it is named after the famous Russian chemist, Dmitri Ivanovich Mendelyeev*, who originally established the relationships of the chemical elements and listed them in the form of the periodic table. Although Lothar Meyer in Germany had indicated in 1864 that certain properties of the elements were a periodic function of their atomic weights, it is the Russian chemist who is regarded as the effective originator of the periodic law.

The success of Mendelyeev's arrangement lay not only in the succession of the numbers representing the atomic weights but in his emphasis on the repetition of physical and chemical properties at definite intervals. Where the periodic properties appeared to break down, he boldly proclaimed that in some instances the accepted atomic weights were grossly in error, while in others allowances must be made for elements not yet discovered. It was in this latter connection that the periodic law achieved its most striking success because in three cases in particular, the discovery of the actual elements provided a brilliant vindication of these predictions. These were gallium in 1875, scandium in 1879, and germanium in 1886.

If Dmitri Mendelyeev could return to life today, he would unquestionably be fascinated by the periodic chart which hangs on the wall of my office. First, he would probably be astonished to see that it listed 102 elements. When Mendelyeev first made up the periodic chart, only some 88 chemical elements were known. At that time uranium was the last (the heaviest) element on the chart; there was nothing beyond that. Another thing on my chart which Mendelyeev would find completely new are the atomic numbers, the numbers representing the number of protons in the nuclei, and of course, also the number of orbital electrons in the atoms. In his day nothing was known about protons or electrons.

There would be many other things about the present-day periodic table that would be completely new to Mendelyeev, but the chances are he would be most astonished by the new elements, those beyond uranium, especially when he learned that all of these transuranium elements were the product of man's own handiwork. The Russian chemist, no doubt, knew something about radioactivity before his death, at 63, in 1907, but in his wildest dreams he would not have dared to theorize that elements could be transmuted; transmutation belonged to the realm of alchemy, not to serious science.

* The Russian name has been transliterated in many different ways; the spelling given here is that given in Webster's New International Dictionary, Second Edition, 1957.

Although all of the transuranic elements are of intense interest from a scientific standpoint, the one that is of greatest importance from a practical standpoint is the element plutonium. Plutonium was completely unknown and probably did not exist to any appreciable extent before 1942. Its great importance lies in the fact that it, like uranium-235, is fissionable and, therefore, can be used as a source of energy of explosive violence, or in a nuclear reactor it can be made to liberate energy slowly and thus make possible the production of useful power.

As is now well-known, plutonium (Pu^{239}) is formed as a result of capture of a neutron by a uranium-238 nucleus by the following reaction:

$$_{92}U^{238} + {}_{0}n^{1} \longrightarrow {}_{92}U^{239} \longrightarrow {}_{93}Np^{239} + {}_{-1}e^{0}$$

$$_{93}Np^{239} \longrightarrow {}_{94}Pu^{239} + {}_{-1}e^{0}$$

that is, plutonium is formed from U^{238} through an intermediate element, neptunium, which has a halflife of 2.3 days. Plutonium-239, however, has a halflife of some 24,000 years, which is fortunate for its practical use.

Beyond Plutonium. Plutonium and neptunium were first produced in minute quantities by E. M. McMillan and P. H. Abelson in 1939 and 1940. These were the first transuranium elements to be discovered. Since that time, as a result of the remarkable new techniques of quantitative ultramicrochemistry, a number of new transuranic elements have been discovered, bringing the total number of chemical elements up to 102. These elements are Americium-95, Curium-96, Berkelium-97, Californium-98, Einsteinium-99, Fermium-100, Mendelevium-101, and last of all, Nobelium-102. These have halflives varying between a few hours or less to several thousand years, but none has been produced in anything more than minute quantities. The availability of these elements is generally of the order of a few millionths of a gram, so it is necessary to work on a scale very much below even that of microchemistry. The technique of qualitative chemical analysis on such a small scale goes by the name of ultramicrochemistry. By using extremely small volumes, of the order of 10^{-5} to 0.1 cc, and weighing microgram amounts, it is possible to obtain solutions containing from 0.01 to 100 grams per liter. Such concentrations are those of ordinary chemistry, and are far greater than are involved in tracer work; consequently, the common chemical reactions can be performed without the use of radioactive carriers.

Beyond Nobelium. Nobelium is the last element listed on the modern periodic chart. Its atomic number is 102. There is a blank space for 103, but this element has not been discovered.

Recently, Dr. Glen Seaborg of the University of California, who has had much to do with the discovery of the transuranic elements, was asked whether there might be a chance of finding a stable element beyond 103. All of the transuranic elements are radioactive, therefore unstable. In reply to the question Dr. Seaborg said, "No, I don't think there would be any chance of finding a stable element, and I don't think there is too much of a chance that the trend will be changed; that is, the trend toward becoming shorter and shorter lived. I wish there would be a checking of that trend. It would be great fun to find some of those elements beyond element 103 with longlived isotopes so that the chemical properties could be studied by the tracer technique. The elements beyond element 103 will have chemical properties that will be particularly interesting because they will be beyond this rare earth-like series of elements. All of the elements with atomic numbers 89, through the undiscovered 103, are rare earth-like and are members of the heavy rare earth-like series whose chemical properties are somewhat similar to that of the long-known rare earth series down to the middle of the periodic table. . . . Element 104 would fall back in the main stream of the periodic table."

The difficulty, said Dr. Seaborg, in working in this region is that the half-lives become shorter and shorter; seconds and then milliseconds, and then microseconds, and even shorter as one goes across. Albert Ghiorso and his associates are working on the identification of an isotope of element 103 but, as Dr. Seaborg pointed out, the work is very difficult because of the shorter

and shorter halflives and because of the shortage of starting materials to use as a target element. What is needed in this field of research are neutron fluxes about ten times greater than the present 3×10^{14} neutrons per sq cc per sec that we have at the Materials Testing Reactor in Idaho. With a reactor of such neutron flux it would be possible to produce target materials in sufficient quantities; for example, a milligram of Californium. Compared to the amount of Californium now available — a fraction of a microgram — a milligram would be enormous. This would be bombarded with heavy ions, like carbon or oxygen, so that we would add to the atomic number of 98, six or eight protons, respectively.

* * * *

Working with Uranium. If working in the field of the transuranic elements presents problems, those who are concerned with the handling of some of the more practical materials used in the atomic industry also have problems. Take uranium, for example. By this time uranium is regarded as quite commonplace since it is an essential ingredient in every nuclear reactor. When fabricated into fuel elements as used in nuclear reactors, uranium presents no particular problems in handling.

Uranium, however, oxidizes rapidly, and this makes it difficult to handle during processing, particularly when it has to be machined, and special techniques have had to be developed for the safe handling and storage of uranium turnings, chips, and sawdust. Paul Ziemke of Oak Ridge National Laboratory, who has had much experience in the handling of uranium wastes, describes some aspects of the fire-control techniques required in the handling of uranium chips and cuttings in the following paragraphs:

". . . Although generally considered highly reactive, the intensity of most chemical reactions concerned with uranium increase markedly as the particle size decreases, such as those developed in the average machining operation. The massive section of the metal oxidizes slowly, initially to a golden yellow, then to a brown, and eventually to a black in 3 or 4 days. The turnings, however, oxidize much more rapidly. When ignited in air through spontaneous combustion or rough handling, the chips and turnings are consumed without flame and at a bright white incandescent heat, at the same time emitting copious quantities of acrid yellow to white fumes. Under such conditions temperatures of 1300 C and over prevail. If not quickly brought under control, the metal usually becomes so reactive on its own account, and such high internal heat is generated, that it reacts destructively with most materials with which it may be in contact.

"In the machine shop every effort must be made to keep the turnings at a temperature sufficiently low to resist rapid oxidation. This precaution also results in unoxidized bright waste, which is desirable in the subsequent briquetting operation needed to prepare the waste for recasting. To reduce deterioration of the turnings, it is essential to use coolants of mineral, animal, or vegetable origin free from water. Care must be taken to drain thoroughly all the turnings before placing them in press-top iron containers for transport or storage. This is especially important in the case of uranium sawdust because, under ideal conditions, one cubic foot of such finely divided material may ignite spontaneously in from one to ten hours.

"It is desirable to store and ship turnings in a closed pressure vessel vented in dry air only, or in a dry, closed pressure container covered with a thin film of lard or mineral oil free of moisture. Chips and turnings must be cleaned prior to being delivered into the hammer mill, cutter, or shredder in preparation for the briquetting process. It is advisable to pickle the material with caution during the removal of the oxide film. In the event of an unusual temperature rise, the material should be rinsed only once by a quick dip in cold water. If this proves ineffective, remove the perforated container and douse with copious quantities of hose water to reduce the temperature.

"The baskets of draining material should be dried by a strong draft of hot dry air at from 40 to 50 C. If for any reason the briquetting process should be interrupted for any length of time, the dried material should be spread out in

approximately 3-inch layers to counteract any tendency to heat which it would do when confined in the large container.

"Combating incipient uranium fires is not too difficult if the immediate quantity of uranium involved is not too large, if the ventilation is good, and provided there is space for the emergency squad to move about without restriction. At this point the philosophy of maintaining the scrap in readily handled quantities, such as drums, or large buckets, pays off well, indeed. With the affected container isolated from its immediate, close association with other containers, the extinguishing problem is greatly simplified.

"Success in combating uranium fires is largely dependent upon the intensity of the fire, and the amount of exposed surface area of the burning uranium. Any number of extinguishing agents and propelling devices are on the market, some of which appear to have slightly more merit than others. However, the powders used in the pressure dispensed units tend to pack at the orifice, and this partial solidification prevents instant use in emergencies. Periodic tests will usually prevent this condition from becoming too serious.

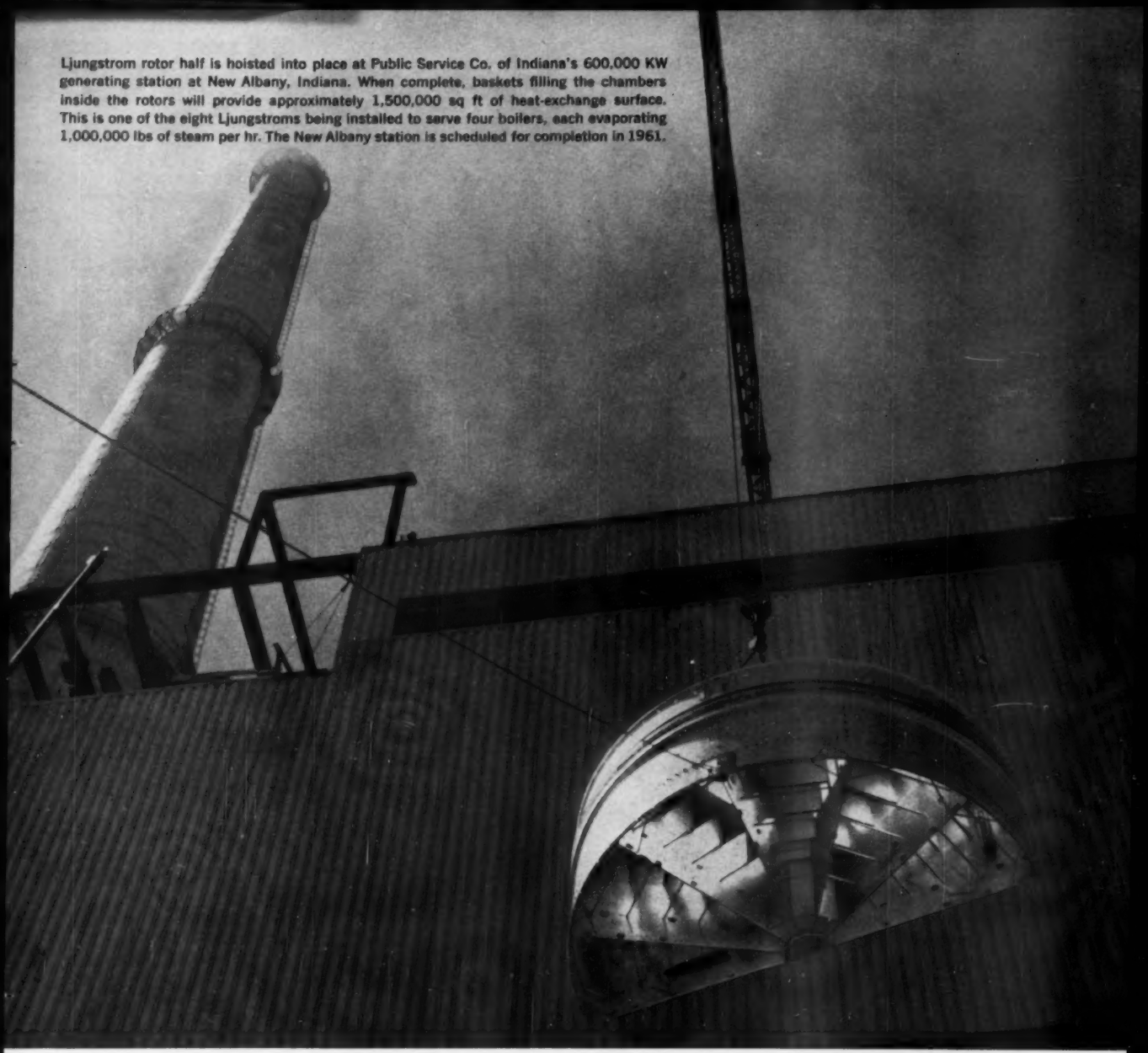
"Substituting powdered graphite for the trade-named powders normally used in CO_2-powered dispensers has proved most effective after some slight alteration in moving the orifice from the bottom to the top of the container. With this arrangement the orifice is no longer subjected to the weight of the mass in the cylinder; consequently, there is no tendency for the powder to solidify in the orifice. Graphite powder is available at most atomic installations operating machine shops to produce graphite parts of various shapes and sizes. The graphite powder is expelled by the CO_2 pressure when the container is struck against a hard object to puncture the cylinder.

"The most effective particle size for the graphite used in extinguishers using CO_2 is that which passes through a 25 mesh screen. All particulate graphite above that size should be segregated in special containers for use by means of hand shovels in fighting uranium fires. Contrary to popular opinion in some processing plants, a little moisture in the graphite when applied to uranium fires presents no hazard when it is laid in reasonably thin layers. Actually, slightly moist graphite permits handling a large, heaped shovelful with little chance of it becoming airborne.

"For large chip-handling projects it is advisable to install a stationary type CO_2 gas-propelled extinguisher system that is piped to the areas of highest exposure and triggered by a rate-of-temperature-rise device, or manually. Coupled with such an arrangement will be an automatic alarm feature to cause evacuation of operating personnel, shut off ventilation, and close weight-actuated doors."

It is obvious, from Mr. Ziemke's discussion, that uranium is a strange material in more ways than one. It combines chemically with many other materials, but its high rate of oxidation is the characteristic which creates the most difficult problems from a practical standpoint. Unlike plutonium, however, uranium is not sufficiently radioactive as to constitute a biological hazard; it can readily be handled. Plutonium, on the other hand, being a strong alpha emitter, can be handled only in a dry box.

Andrew W. Kramer



Ljungstrom rotor half is hoisted into place at Public Service Co. of Indiana's 600,000 KW generating station at New Albany, Indiana. When complete, baskets filling the chambers inside the rotors will provide approximately 1,500,000 sq ft of heat-exchange surface. This is one of the eight Ljungstroms being installed to serve four boilers, each evaporating 1,000,000 lbs of steam per hr. The New Albany station is scheduled for completion in 1961.

BEHIND NEW ALBANY'S **LJUNGSTROMS®** —**LIFETIME AIR PREHEATER SERVICE**

One of the major reasons why Public Service Co. of Indiana, Inc., chose Ljungstrom for its new generating station at New Albany is Lifetime Air Preheater Service.

Lifetime Air Preheater Service means that Ljungstrom engineers make regular calls *throughout the life of each unit.* They check to make sure your Ljungstroms are working at top efficiency, and that they'll continue to work that way. This service policy covers all Ljungstroms—right from the very first installation made in 1923.

But that's not all. Air Preheater provides first-rate *emergency* service, too. For instance, a Ljungstrom customer in the southwestern U.S. recently called on a Wednesday night for replacement parts. Air Transport looked like the fastest way, but schedules indicated a minimum three-day delivery time. So Air Preheater loaded the parts on a pickup truck, and their men drove them more than 1,000 miles to their destination...34 hours straight driving. The parts were installed and in service by Friday morning.

Fast response to emergencies and regular inspection of Ljungstrom installations are two of the many advantages Air Preheater provides. Another is expert knowledge of boiler and preheater problems gained from over 35 years' experience. Perhaps these reasons explain why 9 out of 10 preheaters sold today are Ljungstroms.

THE AIR PREHEATER CORPORATION

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These P.F.I. Standards are packed with vital data on the design, the fabrication and erection of high pressure and high temperature piping used by all industry. However, these technical bulletins do not explain the many advantages of shop fabrication.

Remember, shop fabrication by the companies responsible for the development of P.F.I. Standards is your only real assurance of meeting the most exacting requirements of piping, whether it's welded, bent, coiled or vanstoned . . . in any metal as a component or a complete assembly. Write for all P.F.I. Standards or indicate in the coupon below which ones could be helpful to you.

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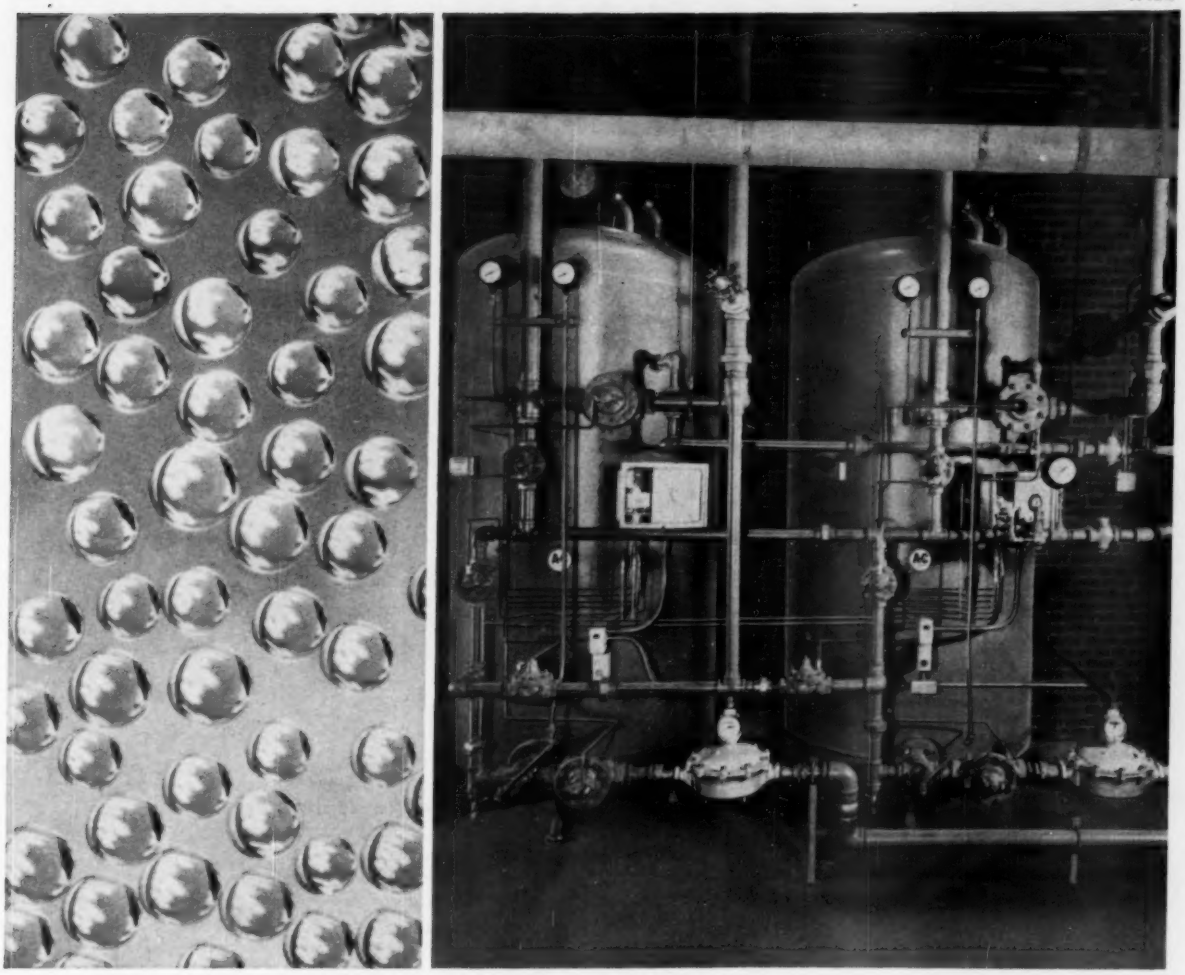

Left, zeolite resin magnified 40 times. **Right,** completely automatic, multiple-valve, dual sodium softeners in Southwest mercantile building.

With Allis-Chalmers Sodium Zeolite water softener in your plant,

hard water vandals turn into "softies"

Fair exchange to an Allis-Chalmers zeolite water softener means a simple switch to sodium ions from the usual hardness present in most water supplies. Calcium and magnesium are the vandals that cause scale in pipes and boilers, clog systems and mean heavy use of cleaning compounds. Zeolite is their natural enemy. But once A-C conditioned, the "softened" water finds ready use in hospitals, institutions, hotels . . . in processing foods and beverages . . . treating municipal water . . . in chemical plants. It ends scaling of manufacturing plant boilers, pipes and heat exchange tubes. A-C standard designs carry a full selection of options to meet any installation problem, local code or custom use. Look to A-C for all of your water conditioning equipment, chemicals and service.

For complete details, call your nearby A-C office or write ***Allis-Chalmers,*** *Power Equipment Division, Milwaukee 1, Wis.*

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HAGAN NEWSLETTER—MARCH

Behind the panel

HOW TO CONTROL 42 SOAKING PITS FROM A 50-FOOT CONTROL HOUSE

A major steel producer engaged in an expansion program projected the building of 42 new soaking pits, arranged in 14 rows of 3 pits each, but the space available for a centralized control house was only 50 feet long. This problem was presented to Hagan, along with certain considerations that had to be observed. These were--the panel must provide high visibility of pit temperatures, heaters wanted to be able to see the entire trend of the heat on recorder charts, metallurgists wanted daily access to individual pit temperature and fuel flow records, the instrument department wanted chart changing held to a minimum. Hagan's solution satisfied these seemingly irreconcilable requirements. Here is how it was done: A new Hagan instrument that includes a highly readable pit temperature indicator, plus a 24-hour chart which records pit temperature and fuel flow, satisfied both heater and metallurgist, without the necessity of withdrawing the instrument chassis from its protective case. All row variables--flue pressure, air pressure, combustion air temperature and recuperator temperature--are recorded on miniature 30-day strip charts. The panel width for one row is exactly 42 inches so that the total width for the 42 pits will be 49 feet, well within the specifications. (Details on request. Ask for Item M-1)

HAGAN SYSTEM KEEPS AUTO TIRES AT pH 6.8

At one stage in the curing of tire rubber, it flows through huge tuber tanks where water must be maintained exactly at a pH of 6.8. This part of the process insures the elimination of hairline cracks in tires after weathering. The Hagan system constantly measures water flow into the tanks and, at the same time, the pH of the water. These two signals are combined to adjust the stroke of an acid feed pump which injects an accurately measured amount of acid into the main water system. The two measurements are made so accurately that the pH of the water has been maintained at exactly 6.8 despite widely varying flows. (Details on request. Ask for Item M-2)

BAKING OVEN FOR MISSILE WINGS CONTROLLED BY HAGAN

Missile wings made of honeycomb aluminum covered with a plastic resin must be cured in an oven that not only bonds the plastic to the aluminum core, but also assures a smooth and hard surface resistant to air erosion. The control system programmer establishes the desired temperature and duration of the curing process. Temperatures are slowly elevated and then reduced over a 12 to 24 hour period. A Hagan GT thermostat senses the temperature in the oven and sends a signal to a Hagan Ratio Totalizer. Any error between transmitted temperature and set point brings about the regulation of a blending damper controlling the amount of ambient air blended with electrically heated air. Engineers like the system because of its simplicity and the ease with which programs can be changed to meet new conditions. After two years of operation, the system has proved extremely accurate, and maintenance has been only routine. (Details on request. Ask for Item M-3)

BASIC OXYGEN STEEL PROCESS CONVEYORS GO PNEUMATIC

Among the steel companies who are making use of the new basic oxygen process, one has come to the conclusion that the best way to convey burnt lime and limestone to the vessel is pneumatically. And, to make sure that the system works accurately and with the least possible maintenance, the control system should also be pneumatic. On this particular system, Hagan controls the flow of material from the track hopper to the holding bin to the batch hopper. At each point, interlocking controls assure that the flow of material will be uninterrupted and will arrive at the vessel in the exact quantities demanded by the operator. In operation for over two years, the system has proved efficient and dependable and has required only routine maintenance. (Details on request. Ask for Item M-4)

HAGAN CHEMICALS & CONTROLS, INC., Hagan Building, Room 711, Pittsburgh 30, Pa.

HAGAN DIVISIONS: CALGON CO. — HALL LABORATORIES — BRUNER CORP.

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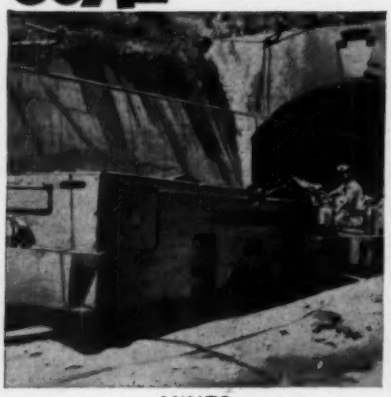
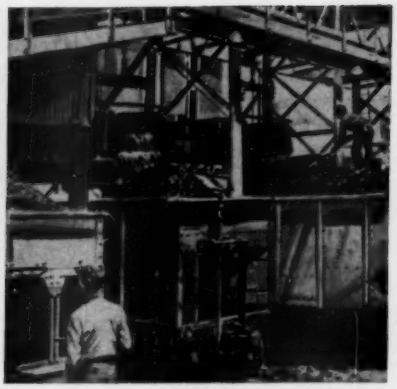
BEACON COAL HAS WHAT IT TAKES

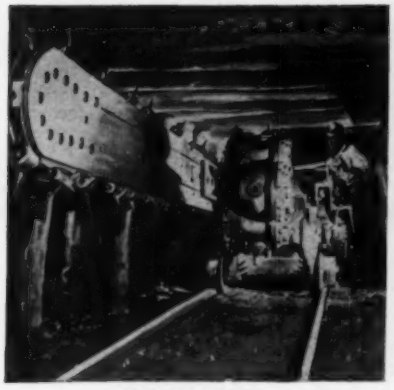
MEN



MINES



CAPACITY



EQUIPMENT

PREPARATION

QUALITY CONTROL

To give the electric utility industry the coal, the assurance, and the service it needs

Next time you write the specifications for the kind of *coal* you want, why not jot down the specifications of the kind of *supplier* you would like to have . . . and see how we measure up!

We have been serving electric utilities for many years, and feel that we know intimately their needs and problems. Our 15 mines provide a variety of coals, and a potential that can deliver up to 15 million tons a year at need. Modern mechanization plus skilled miners equip us to gear production to virtually any emergency you might encounter, and mine location on a number of major railroads gives wide latitude in routing. We maintain close check on quality in our laboratories. Our representatives are men who have made coal their life work and the serving of customers their highest aim. Finally, our past record, if you care to check it, provides complete assurance that you will get the coal you want, when, where, and as you want it.

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BEACON COAL

EASTERN GAS AND FUEL ASSOCIATES — BEACON COAL

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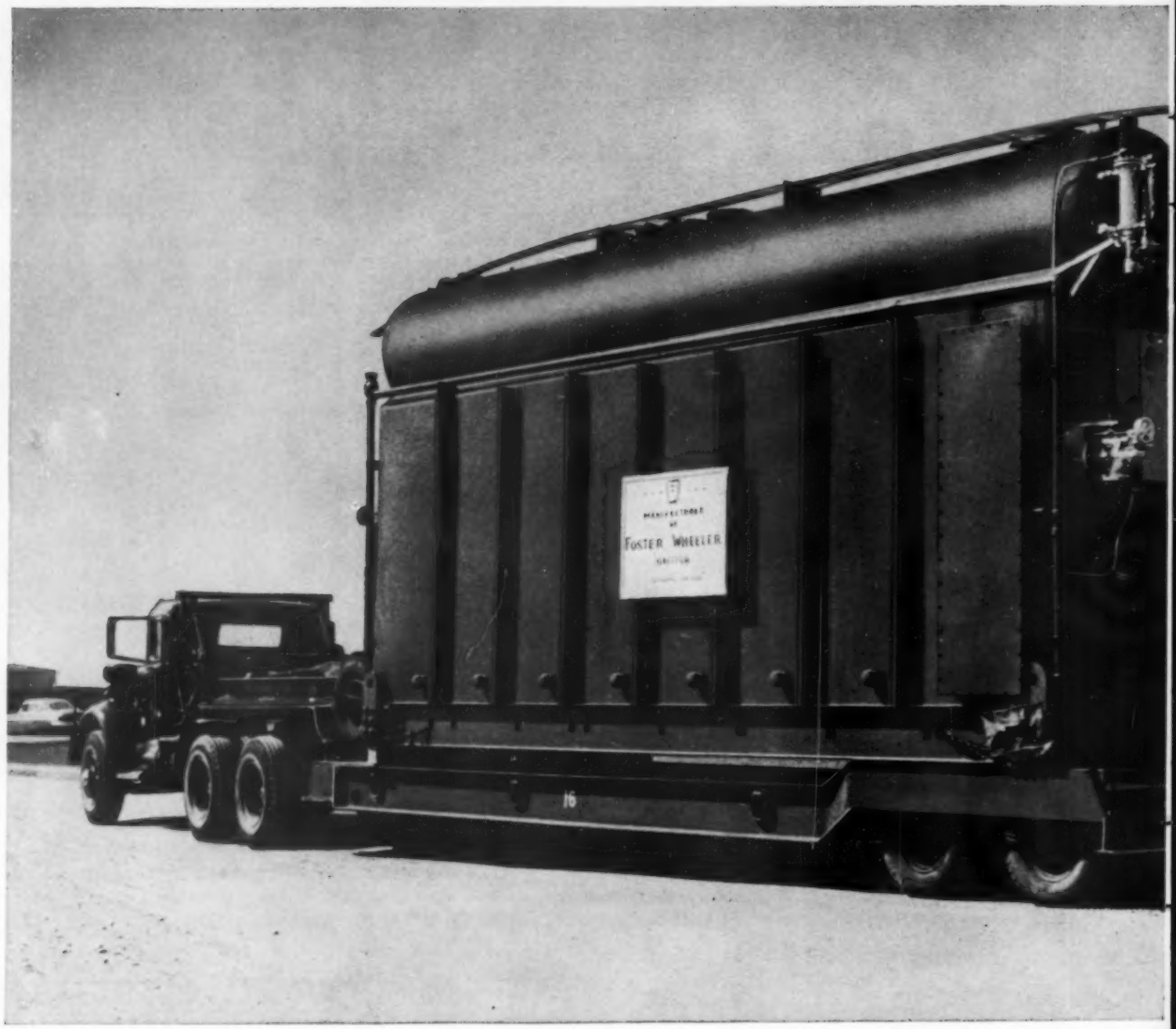
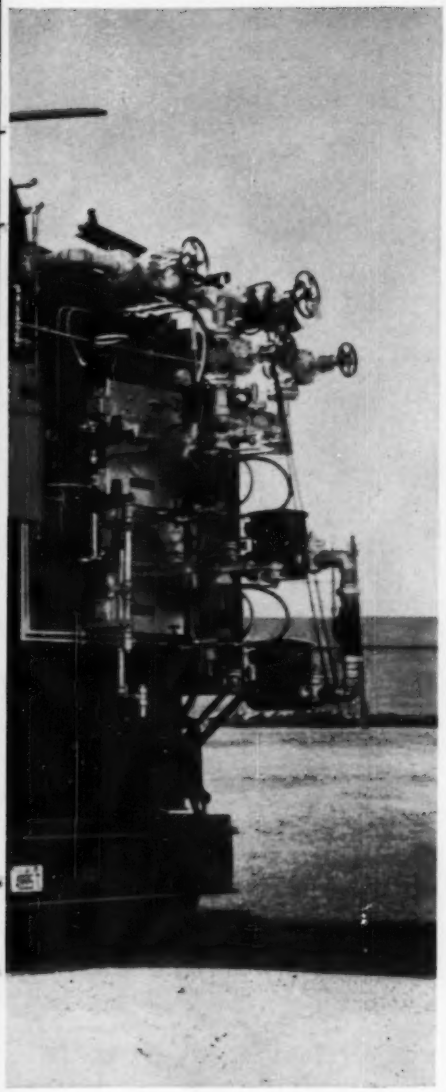


Foster Wheeler Packaged Steam Generator on its way to a refinery, where it is now producing 50,000 lb/hr of high-purity steam for processing and heating purposes.

—PETROLEUM PROCESSING

—CHEMICAL PROCESSING



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If you need 13,000 lb/hr or more of steam at pressures of 250 psi or above, one of the best ways to begin planning your steam generator installation is by contacting Foster Wheeler right now.

This is Foster Wheeler's record of experience in meeting steam requirements with packaged steam generators.

The first water tube shop-assembled packaged unit was built by Foster Wheeler in 1940, to solve an important defense problem. Today, standard Foster Wheeler Packaged Steam Generators, firing fuel oil and gas separately or in combination, are serving refineries, process and manufacturing plants, hotels, dairies . . . virtually every type of business and industry throughout the world.

Most recent Foster Wheeler development in packaged steam generators is a stoker fired model, the first available to industrial users of steam.

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Heat Engineered products, plants and processes . . . for the world's power, petroleum and process industries.

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When you need...

- Quick action
- Leak-Proof Seal
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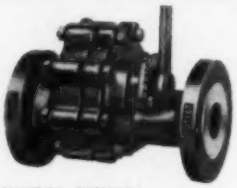
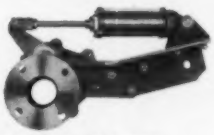


GENERAL SERVICE
Where drop-tight seal and full flow is essential.



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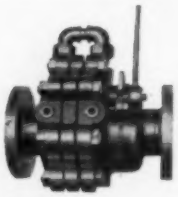

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For automatic drains or emergency shut off.

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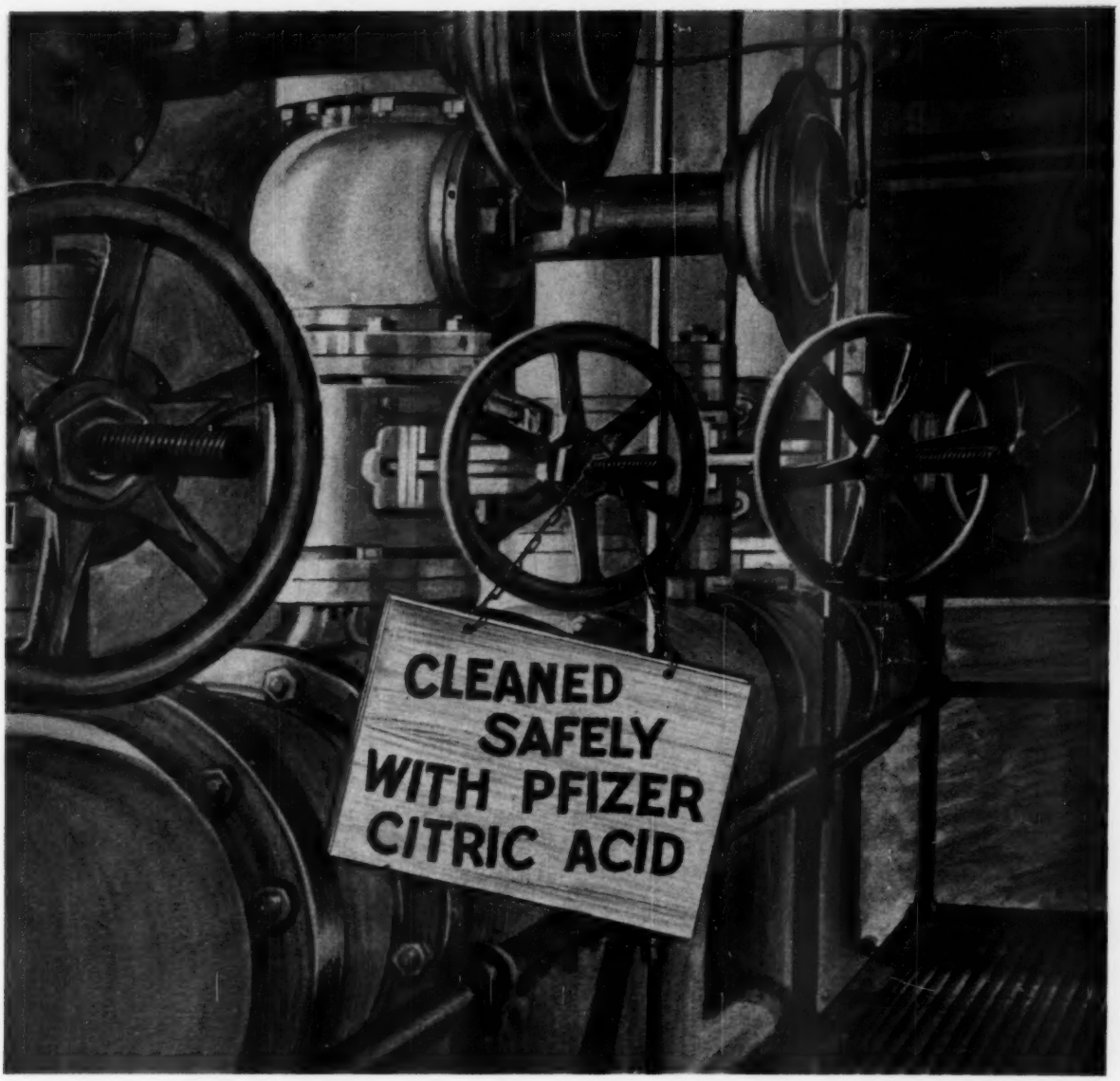

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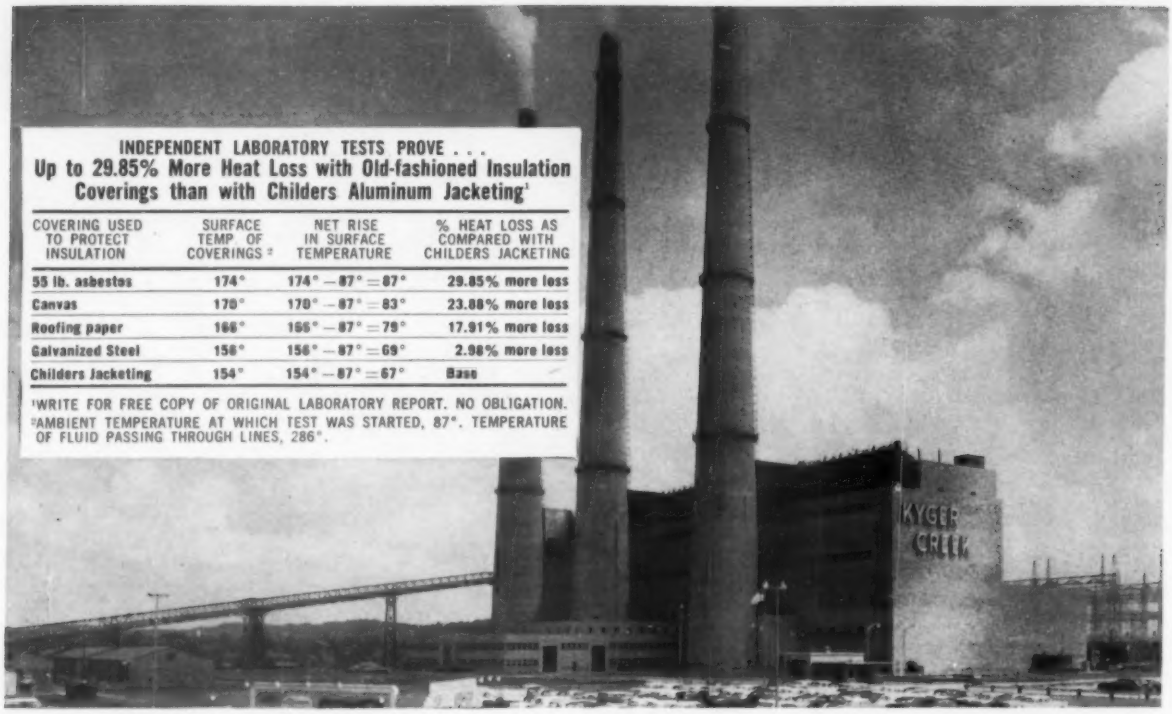

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Up to 29.85% More Heat Loss with Old-fashioned Insulation Coverings than with Childers Aluminum Jacketing[1]

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55 lb. asbestos	174°	174° — 87° = 87°	29.85% more loss
Canvas	170°	170° — 87° = 83°	23.88% more loss
Roofing paper	166°	166° — 87° = 79°	17.91% more loss
Galvanized Steel	156°	156° — 87° = 69°	2.98% more loss
Childers Jacketing	154°	154° — 87° = 67°	Base

[1]WRITE FOR FREE COPY OF ORIGINAL LABORATORY REPORT. NO OBLIGATION.
[2]AMBIENT TEMPERATURE AT WHICH TEST WAS STARTED, 87°. TEMPERATURE OF FLUID PASSING THROUGH LINES, 286°.

More than 500,000 square feet of maintenance-free Childers Aluminum Jacketing protect the insulated lines in this modern Kyger Creek Plant of the Ohio Valley Electric Corporation which was rated first in overall thermal efficiency in recent annual ratings of major power plants by the Federal Power Commission.

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. . . yet cost is less than canvas-and-paint

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First cost is less for maintenance-free Childer's Jacketing—*actually less than canvas-and-paint.* You protect your insulation investment at lower cost and get the bonus of a better looking plant and easier housekeeping.

Compare . . . Figure YOUR Savings:

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8 oz. canvas covering	$ .167
One coat of paint	.044
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CHILDERS .006" Aluminum Jacketing	.184
Your SAVING per sq. ft.	$ .027

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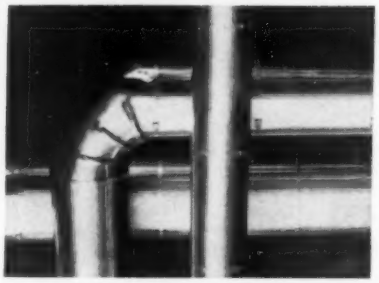

CHILDERS FEATURES CUT COSTS:

1. NEW CHILDERS ALUMINUM ELL-JACS solve costly problem of protecting insulated elbows. Give you permanent protection. Precision-formed for both 90° and 45° long-radius ells.

2. EXCLUSIVE LAP-SEAL, available at no extra cost, is a series of 8 ribs rolled into the underlapping edge of jacketing, providing automatic measure of the 2" circumferential lap.

3. FACTORY-ATTACHED MOISTURE BARRIER protects the underside of the aluminum from possible attack by alkaline solutions present in many insulating materials, eliminates the need of applying a separate moisture barrier.

4. CROSS-CRIMP increases strength of jacketing, cuts material cost.

ONLY CHILDERS MAKES AVAILABLE TO YOU COMPLETE SPECIFICATIONS AND ENGINEERING DATA ON ALUMINUM JACKETING IN THESE CATALOGS: SWEET'S INDUSTRIAL CONSTRUCTION FILE PP. 108/CH; CHEMICAL ENGINEERING CATALOG PP. 945-948; REFINERY CATALOG PP. 375-378.

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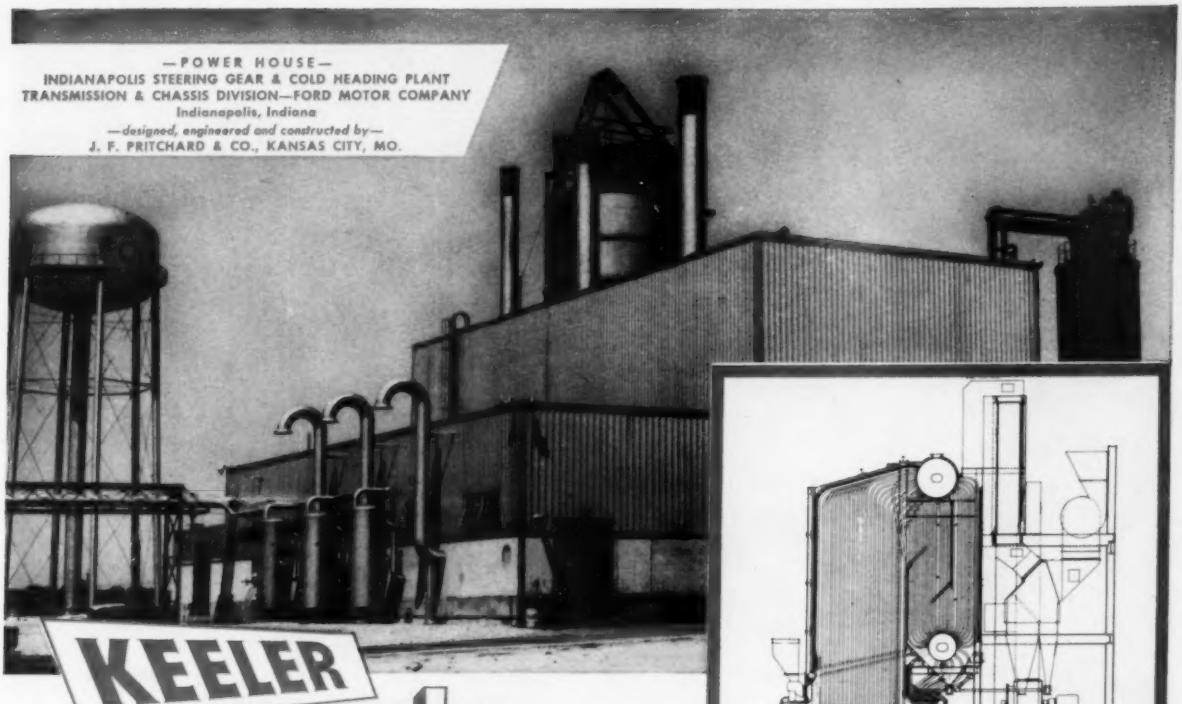

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INDIANAPOLIS STEERING GEAR & COLD HEADING PLANT
TRANSMISSION & CHASSIS DIVISION—FORD MOTOR COMPANY
Indianapolis, Indiana
—designed, engineered and constructed by—
J. F. PRITCHARD & CO., KANSAS CITY, MO.

KEELER

MK

water tube steam generators

available in capacities from 12,000 to 200,000-lb stm/hr

95 years of design and manufacturing experience provides the basis for steam efficiency and economy at Ford plant

Three Keeler Type M K Steam Generators are serving Ford's Indianapolis Steering Gear & Cold Heading Plant with complete satisfaction on all points. They were selected for their ability to economically deliver 300,000-lb stm/hr for the plant's entire process, heat, hot water and auxiliary equipment requirements.

Two of the M K's are 120,000-lb stm/hr and the other is 60,000-lb stm/hr, 160 psi design pressure. They are equipped with air preheaters and spreader-stokers with continuous ash discharge, for bituminous coal firing—providing as modern and efficient a power facility as the manufacturing plant itself!

Keeler M K Steam Generators offer many efficiency and economy advantages! They are fully top supported, cross drum type with provision for downward expansion to eliminate any stresses being conveyed to the boiler proper, the steam piping or auxiliary equipment. Radiation losses are held to an absolute minimum with water cooled, completely steel encased and insulated furnace walls and roof.

Write or phone for complete information . . . Keeler M K's are available in capacities from 12,000 to 200,000-lb stm/hr—for high efficiency with any firing method or control system.

ONE OF THE NEWEST PLANTS in the Ford Motor Company's Transmission & Chassis Division, the Indianapolis Steering Gear & Cold Heading Plant is Ford's biggest producer of steering gear units for all company cars and trucks, and one of the largest cold heading operations in the world. The main building comprises more than 1,400,000 square feet of floor space—housing production, office and various employee facilities, including a fully staffed hospital and three cafeterias.

The Seal of Quality in Water Tube Steam Generators

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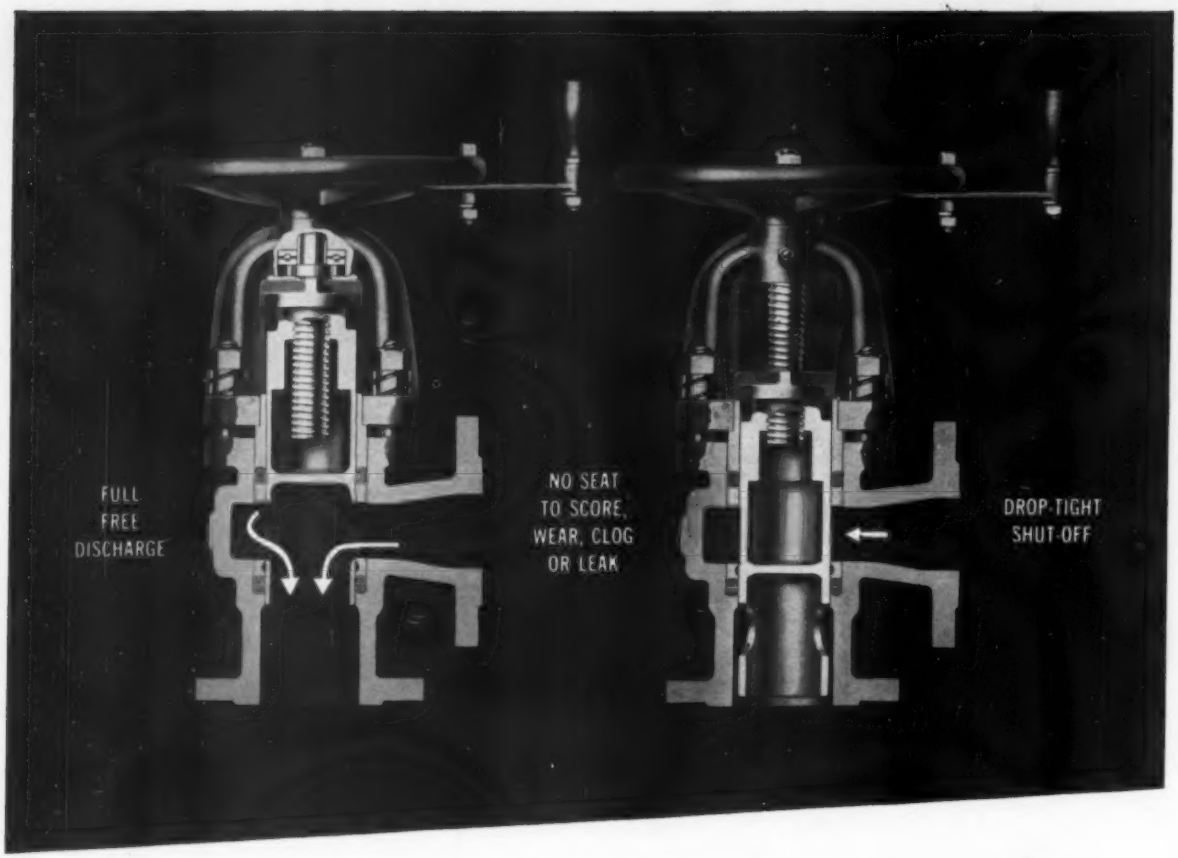

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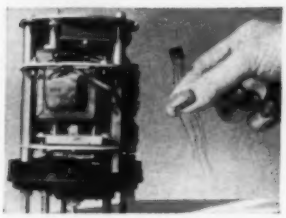
TRACERS

Power Engineering's Monthly Probe of Power Facts



The Hall multiplier, a new watt-measuring device developed by Westinghouse, now serves as a watt transducer, where it converts a-c watts to d-c millivolt signal. Watt transducers supply a signal, proportional to measured watts, for application to a control device, or to a telemetering transmitter. Up to now, this field has been dominated by the thermal converter. In control circuitry, the watt transducer has a speed of response in microseconds as compared to a time constant of about one second for the thermal converter. Cost is reported to be lower, space less.

Field tests have proved the practical value of automatic controls on electrical fly ash precipitators. On a typical unit, average power input was 3½ times that achieved with manual control — or greatly more efficiency, yet with sparking held to a minimum. L. L. Little and C. R. Zink give other results in their article on page 64.

A low-cost nuclear steam generator that can operate anywhere — it's an important goal in the planning of AEC, and a prospect of keen interest to industries using steam under pressure. Report is that AEC will build the first atomic plant to serve industrial processes, at Point Loma, Calif, near San Diego.

Almasol is opening up new vistas of solution to problems of industrial lubrication and coating. What is Almasol? Turn to the article by R. J. Neely and Everette O. Walden, page 76 of this issue.

Battle against corrosion, reports the American Society for Metals, has been aided by a new method of depositing heavy coatings of aluminum on steel and other metals. It's called vapor coating. Aluminum is boiled in a vacuum and permitted to condense on the object to be coated. In this way an aluminum surface as thick as 0.004 in. can be deposited. Up to now, it has been possible to deposit only an extremely thin film of aluminum on another surface.

Pioneering step in the gas transmission field will be a new jet-powered compressor station to be built at Clementsville, Ga, by Columbia Gulf Transmission Co. Its 10,500-kw gas turbine utilizes a modified Pratt & Whitney J-57 jet aircraft engine. Thrust of the gas-fueled unit is converted into rotating horsepower by a Cooper-Bessemer turbine, and this drives a centrifugal compressor.

Generating cycle combining a steam turbine and a gas turbine will be used for the first time in the production of electric energy by a coal-burning plant. This pioneering installation will be made at the Muskingum River plant of the Ohio Power Co at Beverly, Ohio. A 5000-kw prototype turbine driven by coal gas will be built adjacent to the plant's 215,000-kw steam turbines and will supply combustible by-products to the steam boiler, reducing the amount of coal required by the boiler. Improvement in over-all efficiency from the combination cycle is expected eventually to reach 4 per cent.

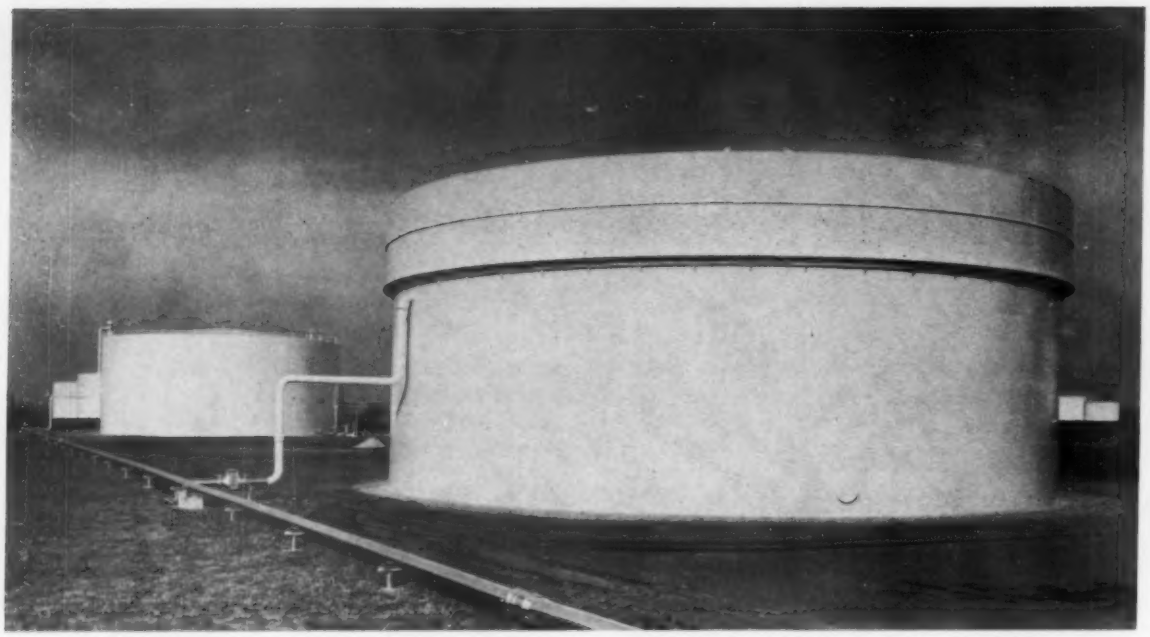


Fig. 1. This 55,000-bbl-capacity tank (front) is 100 ft in diam and 40 ft high, is widely used by oil-refining industries

Field-Erected Steel Tanks

Storage tanks are universal items of equipment in the power field. Too often, they are taken for granted; however, many factors are considered in their design. An expert describes the common types, and explains the characteristics of each. This is the first of two parts

By GEORGE S. TREES *

Why This Article

Today, when you leave your office for home—or vice versa—chances are you'll be surprised at the number of steel storage tanks along your route. Most people have little idea of the role thousands of these steel sentinels have in modern America, both in rural and highly industrialized areas.

As you might guess, most tanks store water or petroleum products. However, many people who are occasional or potential buyers see something of the "unknown" in these structures.

This article is intended to reveal basic information about steel storage tanks. In layman's language it tells their purpose, how they are built, how they operate, how they are maintained—and, in general, how much they cost.

TANKS FOR STORAGE of water can be built at ground level or elevated on towers; they can be used for potable or process water.

Tanks for petroleum storage are built in accordance with American Petroleum Institute (API) Specifications. These tanks may be used for the storage of low flash-point fuels, such as No. 6 fuel oil, or for lighter products, up to and including gasoline. If the vapor pressure of the product is high enough to cause excessive evaporation, various vapor-saving devices — such as floating roofs, lifter roofs or pressure storage — are used. The most common type of oil storage tank has a cone roof.

Elevated Water Tanks

Many industrial plants use elevated water storage to provide a definite water pressure for: 1. Their factory operations; 2. for positive fire protection; or 3. to balance their pumping load. Elevated water tanks range in size from 25,000 to 2,500,000 gallons. As a general rule, it is not economical to build small elevated water tanks, such as 25,000 gallons, because the cents-per-gallon cost is extremely high in the smaller sizes. Also, most insurance companies do not recognize fire protection or sprinkler tanks smaller than 50,000 gallons.

There are several types of elevated water tanks. The most common is the double ellipsoidal design, which is usually elevated on tubular steel columns. Figure 6 illustrates a conventional 100,000-gallon elevated tank, raised 100 ft to the bottom of capacity.

In recent years, however, there has been an increasing trend towards tanks which combine efficient service with streamlined appearance. The most popular of these is the Watersphere, Fig. 2, which is built in capacities ranging from 50,000 to 250,000 gallons. The Waterspheroid, shown in Fig. 4, was developed to

* Chicago Bridge and Iron Co, Pittsburgh, Penna

Fig. 2. Watersphere tank is streamlined, efficient

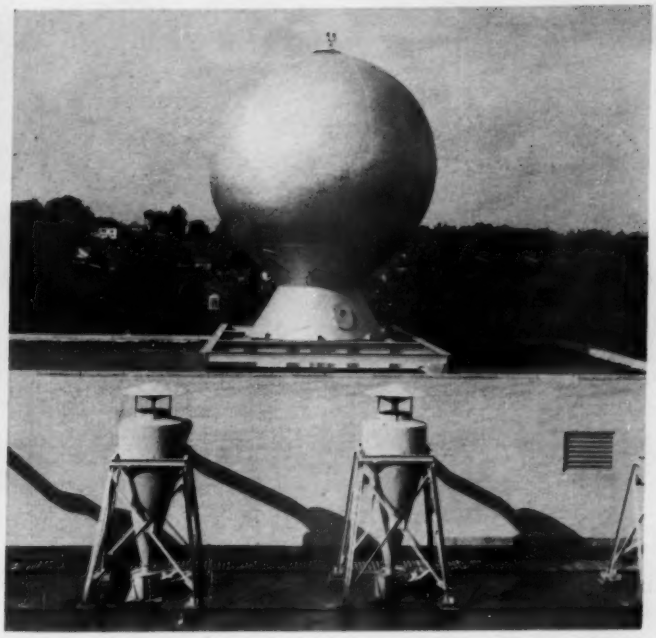


Fig. 3. This larger 75,000-gal Watersphere is also unique in design

provide attractiveness for tanks of larger capacity — up to 500,000 gallons.

Elevated Waterspheres and Waterspheroids have many advantages in addition to aesthetic appearance. Each has a non-water-bearing column which supports the tank proper. Both types of tanks require less ground space than the comparable double ellipsoidal design. They have less painting area, and the base can serve as a large storage area, or to house pumping equipment.

If the building is designed to carry the load, tanks frequently are erected on the roof. Figure 3 shows an example of this construction.

In the small capacity tanks (ranging from about 25,000 to 75,000 gallons) it is possible to effect economies by using a tripod design.

Tanks built to insurance specifications will require a heating device if the lowest one-day mean temperature is lower than 5 F or below. This can be accomplished by either a radiator type heater or a hot water circulating type, which is operated with a heat exchanger. The double ellipsoidal design is usually built with a 3-ft- or 4-ft-diameter steel riser, which is water-bearing and is easily heated with a radiator type heater.

The tripod and Watersphere designs must have hot water circulating pipes, to protect the pipe riser, and also to provide heat in the tank itself. Both types of heaters normally operate on steam pressures from 10 to 50 psi. Usually the heater is controlled by a thermostat, which actuates the flow of steam when the temperature of the water reaches 42 F.

Ground-Level Water Tanks

On a cents-per-gallon basis only, ground-level water storage is more economical. If the topography of the land permits, these tanks can be built on the ground at an elevation sufficiently above the plant to give the necessary pressures. Flat-bottom tanks, as they are called, generally are built on a ringwall foundation with the center area inside the ringwall being filled with crushed rock, sand, gravel, or other well-compacted material.

If these tanks are built for insurance purposes, and are at the same ground elevation as the plant, they normally have a pump included, which turns on automatically if one of the sprinklers opens. If heating is required, it is accomplished by using steam coils, which are placed near the bottom of the tank.

In many cases a ground-level tank is built, in addition to an elevated tank, for supplementary storage. A ground-level tank can be built with a self-supporting roof, or it can be column-supported. Figure 5 shows a typical 150,000 gallon umbrella roof water tank, and Fig. 7 shows the conventional cone roof with a column support.

The main advantages of the self-supporting roof are: 1. appearance, and 2. to keep the rafters and columns out of the water — because of ice conditions in the winter, if the tank is not heated.

Practically all oil tanks are ground-level, or flat-bottom tanks. They usually have column-supported roofs, unless other roof types are needed for evaporation, corrosion, or fire protection reasons. The API Specifications which govern these tanks permit the use of $\frac{5}{16}$-in. shell plates, if the diameter of the tank is less than

Fig. 4. Elmhurst, Ill, uses attractive 500,000-gal-capacity Waterspheroid

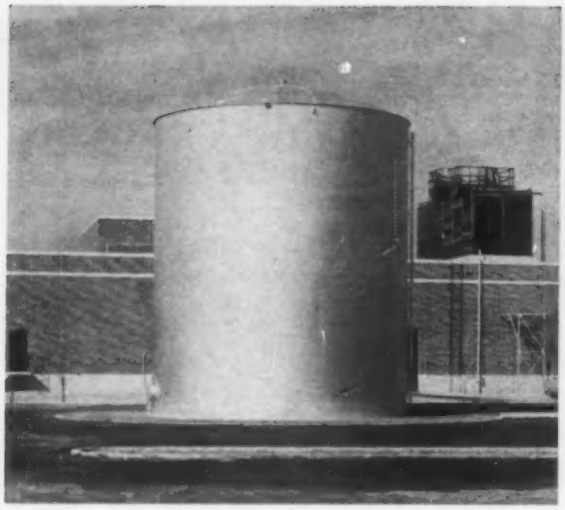


Fig. 5 shows 150,000-gal flat-bottom tank with umbrella roof

Fig. 6 shows 100,000-gal-capacity ellipsoidal elevated tank

50 ft and the design criteria will permit.

Conventionally, these tanks are built with ¼-in. bottom plates and $^{3}/_{16}$-in. roof plates. From 50 to 120 ft, the specifications call for a minimum thickness in the shell of ¼-in. plate. Diameters greater than 120 ft require $^{5}/_{16}$-in. minimum shell plates; and over 200 ft the minimum is ⅜ in. As a general rule, the saving in using $^{5}/_{16}$-in. plates in the shell (in smaller tanks) is sufficient to make it worthwhile.

Oil tanks generally do not have heating equipment. However, if No. 6 fuel oil, or other heavy products, are stored, heating is required to move the product rapidly. This is sometimes accomplished by the use of suction heaters, with steam coils, or with both. Tanks for heavy fuel oil are insulated in northern climates to prevent large heat loss.

Oil tank capacities are generally stated in petroleum barrels of 42 gallons. Field-erected tanks are normally built in sizes from 5000 to 268,000 barrels. Among the most popular sizes are the 55,000-barrel tank, which is 100 ft in diameter and 40 ft high, and the 80,000-barrel, which is 120 ft in diameter and 40 ft high. Shipside and pipe line terminals require much larger tanks — ranging up to 300,000 barrels each.

Zoning, or fire prevention ordinances, may require the use of special oil storage tanks. Also, the storage of volatile products, such as gasoline, dictates the use of conservation roofs. A floating roof, Fig. 8, floats on the product. This roof reduces corrosion, provides excellent fire protection, and reduces the evaporation loss from products with high vapor-pressures. The lifter roof, shown in Fig. 1, rides on the vapor space above the gasoline, and has a trough with oil (or water seal) and dip-plate sealing arrangement.

In some densely populated areas, underground tanks have been built. These are usually rectangular. One view is shown in Fig. 8. This method of storage is used frequently in the New York City area, for space conservation and because of fire ordinances. Since the tank must be designed for the external earth load (with heavy stiffeners), it is more expensive than a tank of the same capacity built above ground. How-

Fig. 7. 75,000-gal tripod tank on roof

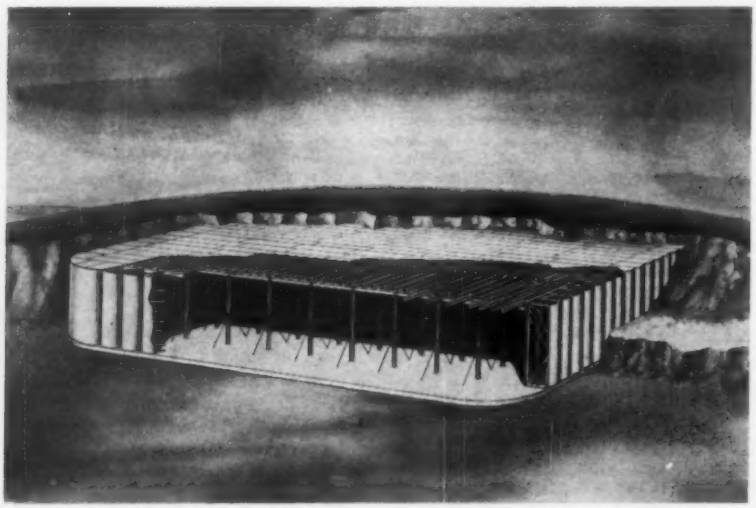


Fig. 8. Cutaway view of 5,000,000-gal-capacity underground tank reservoir

ever, the air space above the tank can be utilized.

Many other products are stored in steel tanks, such as chemicals, caustic, acid and dry materials. Steel tanks also have been built economically and satisfactorily for fly ash and for grain. For most of these products, special design considerations are required. In these areas there are no all-inclusive specifications, so a good deal of judgment in design must be exercised.

An experienced and responsible designer, fabricator, and erector can be a great help. When experienced fabricators design a tank which is not covered by a particular specification, such as API or AWWA, they usually assume a conservative unit stress which will vary with the product stored. With ASTM A283 material, 18,000 psi, with a joint efficiency of 85 per cent, is in common usage for shell design purposes.

If caustic is involved, many people drop the basic unit stress to 16,000 psi. Certain acid and caustic tanks require much more care during construction. Welding is carefully controlled and cold-torch stress relieving may be employed.

To be continued

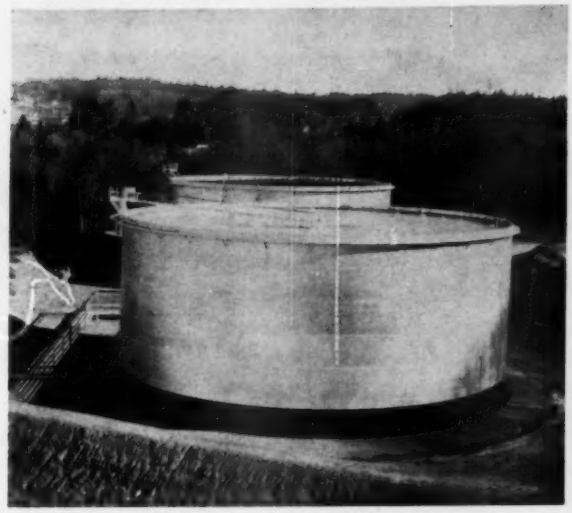


Fig. 9. This view shows two Horton double-deck floating roof tanks

Editor's note: The second part of this article, in a coming issue, will deal with maintenance and painting; tank purchase, fittings, testing, and costs; and welding specifications.

Modern Ash-Sluicing Methods Pile Up Benefits

FORMER CRITICS of the ash-sluicing method have had their thinking sharply reversed recently. Bituminous Coal Institute indicates that utilities have shown considerable interest in sluicing fly ash in settling basins, thus eliminating a serious air pollution problem without causing natural stream pollution.

Use of sluicing to transport objects dates back to primitive man, but it is still a practical means of moving quantities of materials, such as logs, ore, and ash. By definition a sluice is an artificial channel for conducting water, on or in which materials are carried from point to point.

Past Practices

Because industries of the past located generally along rivers and streams, sluicing was a natural means of removing coal ash from boiler plants. These early practices, however, created a stream pollution problem because of the total return of water and ash to the receiving body of water.

Today there are three basic hydraulic systems, applicable to plants of almost any size: 1. high-velocity water; 2. low-velocity water; and 3. hydroejector, or water exhauster.

Ashes are conveyed to an ash storage sump, to a fill or settling area, or to a dewatering or decantation bin. Systems may be closed (as with the sump of a bin) or open.

In hydraulic ash systems, water quantities and pressures vary according to project conditions, such as boiler spacing; nozzle spacing (where there are two or more sluice nozzles); sluiceway length; number, type, and angle of sluiceway turns; and properties of the ash.

The sluiceway, usually concrete, is between 18 and 24 in. wide. Replaceable cast-iron liners can be purchased to protect the concrete from excessive wear. Ash pipelines, normally of 6- or 8-in. pipe, should be designed for the lowest possible velocity that will keep the ash in suspension.

Manufacturers recommend a minimum velocity of 10 fps. Excessive velocity causes excessive wear on both pump and piping.

Ash or recirculating pumps are usually centrifugal-type with single-side suction and opening suitable for the passage of large particles. Exposed pump parts (suction sleeve, impeller, and volute shell) are of hard, abrasion-resistant material.

For easy maintenance in operating position, horizontal-shaft pumps are used in most installations. An ash crusher is an essential part of a system handling large-size ash; clinkers that are too large for the system can disrupt flow.

Ash Can Be Useful

Ash handling need not be an air or stream pollution problem nowadays. It may also have its positive compensations. Sales of ash for cinder block, highway cinders, and fill are growing.

Slag is now widely used as an aggregate for bituminous road surfacing and for coating roof shingles.

Fly ash is applied as an additive to bulk concrete. Instead of being a plant headache, ash is becoming an additional return on every dollar invested in economical coal burning.

Because ash is produced at the rate of 20 to 30 million tons yearly, BCI feels that the subject of handling deserves special attention.

Development of ash-handling systems has kept pace with progress in coal-burning equipment. Many modern coal installations take ash handling in stride as coal cost savings continue to mount up.

CHANGING SHAPES . . .

From Here to the Ultimate

In this analysis, Mr. Barnard points out the "in-between" steps to be taken before the ultimate in power plant control can be achieved. Adoption of these steps must be justified by reduction of costs and/or increase of reliability

PILOT OF AN AIRCRAFT embarking on a flight from New York to Los Angeles is not only concerned with the weather in Los Angeles, which is of course important, but also the weather enroute, which is of equal importance. It appears that many people embarking on a venture into power plant control are more concerned with the ultimate, and are apparently oblivious to what lies between. As in the case of the continental flight, storm centers along the way require careful consideration in the field of power plant controls.

Ultimate requirements in the power industry are simple: to generate and distribute electric power with an absolute minimum of cost, and with one hundred per cent reliability. All other considerations are secondary, except as they bear directly or indirectly on the ultimate targets. Any equipment which does not contribute to lowering the cost of delivered power, or increase reliability, is a poor investment.

Power plant of today is designed basically for manual control, with automatic devices added to it. It would appear necessary that the plant itself, the major equipment, and auxiliary machinery should be designed for automatic control, to take full advantage of the control techniques now available.

In plants burning coal, present coal-handling and -burning equipment is difficult to operate and maintain, and is not suited for complete automatic control without substantial improvement. This involves a considerable amount of engineering and development by design engineers, and manufacturers of major and auxiliary apparatus. While this is being carried on, there are a number of finite steps which may be taken to improve the present and approach the ultimate and which constitute the "In Between."

Adoption of these steps, whether singly or in combination, must be justified by reducing costs or increasing reliability, or both.

1. **Condensed information provided the operator.**
2. **Extend use of interlock and limiting circuitry.**
3. **Automatic sub-loop controls.**
4. **More complete on-line controls.**
5. **Performance computations.**
6. **Complete automatic plant.**

1. At the present time, a large boiler and turbine unit is equipped with instruments and other devices which present the operator with over a thousand pieces of information. These are in the form of indications, analog records, signal lights, annunciator points, position indicators, etc. The operator is also provided with several hundred control points including control stations, push buttons, levers, valves, etc. Certainly substantial improvement can be made in these areas.

Digital scanning-logging-alarm equipment can be used to simplify the information presented to the operator, and to present it in a more easily understood form. Simple computations can reduce this quantity of data as presented to the operator without the investment in general purpose computing equipment. Variable set points in the alarm circuitry will extend the use of annunciators and minimize the amount of numerical information provided the operator, in areas where all he needs to know is whether the unit is within safe limits.

2. Advances in the art of solid state switching permit the extension of interlocking and limiting circuitry to reduce the amount of operator participation in decisions affecting the safety of the plant. Human errors contribute to a large number of failures, and logic and sequencing circuitry may be employed so that the proper decisions are made under emergency conditions.

3. Logic and sequence circuitry may be employed to provide more complete automatic sub-loop controls. For example, complete burner control may be obtained by single push buttons at the operating center, with all sequence operations, interlocking, and monitoring handled automatically. Extension of this concept to other major and minor sub-loops is feasible.

4. More complete *on-line* controls may be provided by extending the logic and sequence circuitry to operate the unit over its full range of operation without operator attention. This involves considerably less equipment than the fully-automatic plant which provides for hot and cold automatic starts, and provides the lowest cost of operation and maximum reliability after the unit has been in service. With equipment of this type, burners, fans, pumps, and the like would be put in and taken out of service automatically over the full range of normal operation.

5. With the reduced amount of operator's attention provided by the above, more time is available to him to make use of performance computations to keep the plant maintained in top condition at all times. For many applications, analog computations provide the most simple, economical means of computating per-

—What's in Between?

MORE ON AUTOMATION

By C. H. BARNARD
Sales Manager, Industry Divisions,
Bailey Meter Co

formance. In addition to over-all heat rate, computation and display of performance in major areas of the heat cycle will assist in pinpointing deterioration of certain equipment, and permit scheduling of maintenance on a truly economic basis.

For very complex systems, a digital data-gathering system may be employed with performance computed periodically on a time-shared digital computer, and in some instances, portable data-gathering equipment will be satisfactory, collecting data at periodic intervals with computations made on a central computer.

Data provided by this means is useful for proper loading of equipment, since loading is based on current performance data, rather than test or design conditions.

6. The automatic plant is achieved by utilizing the foregoing, together with the added equipment necessary to provide for automatic start-up. Many of the features incorporated into each of these steps is germane to the automatic plant, and the final step becomes easier for the operators to understand. Equipment may be installed in steps or initially in any combination, depending on the economics and improvement in reliability expected.

WHILE THE BASIC TECHNOLOGY is available to supply equipment for the fully-automatic plant, as well as any of the outlined intermediate steps, there is a great deal of work remaining in the proper application of the technology, and in the development of equipment required to implement the more complete control.

Equipment designed as described above is relatively easy for plant personnel to understand, which simplifies maintenance procedures, and speeds operator acceptance. It does not require complex programming, nor specially trained technical personnel.

Because the main parts of this system are independent, reliability is increased as there is no dependence on any one system.

A general purpose computer can be used for these functions, but with increased complexity, and less inherent reliability.

Much has been said in recent months about the necessity for improved accuracy and speed of response of instruments in final control elements. There is no question that certain measurements require high accuracy, and developments along these lines are already under way. However, the cost of improved devices compared to the payout must be carefully evaluated, and unrealistic demands for improvements minimized, if cost is to be kept within reasonable bounds.

Accuracies of 0.1 per cent and time constants of less than one second are meaningless for most applications, at least until such time as major and auxiliary apparatus is improved to the point where it may be controlled and maneuvered with this speed and accuracy. Repeatability is generally of more importance than absolute accuracy, and in only a limited number of cases, such as required in certain performance computations, is absolute accuracy of importance.

Manpower requirements in *designing* a fully-automatic plant must be realistically evaluated in view of the cost and time involved. Every detail has to be examined minutely, every operating problem carefully studied in detail, and every conceivable manipulation pre-planned. Estimates of manpower required vary between five and twenty man-years, at least in the early stages, and the availability of competent manpower on this scale is questionable, irrespective of the dollar cost.

As to the matter of cost, many totally unrealistic estimates have been published, and the cost of equipment for the fully-automatic plant is going to be very high. Ultimately, this type of equipment must be sold on a profitable basis, and costs to the user are going to be substantially above those being quoted today. Only time and added experience will dictate the true level of costs.

A LIMITED NUMBER of large plants, having managements with the desire to pioneer, will install fully-automatic plants in the near future. However, it appears that the majority of plants will take some of the "In-Between" steps and wait before installing the ultimate, in order to take advantage of developments which will be made, experience gained, and better substantiated economic justification than exists today. It is well that both are in the power industry, for the first group leads the advances and the second provides the conservatism which has given the utility industry its amazingly high degree of reliability.

A limited number of reprints are available of the special January section, Automation and the Power Field. *Single copies are $1 each. Quantity lot prices will be quoted on request. Address* The Editor, Power Engineering, 308 E. James St, Barrington, Illinois.

Automatic Power Control Improves Precipitator Efficiency

Electrostatic precipitators with automatic power controls are shown by test to be much more efficient than they are with manual control

By L. L. LITTLE and C. R. ZINK *

AUTOMATIC power control on electrical precipitators has become an accepted fact these days. While a well trained technician can maintain a fairly good power control on a precipitator, the routine, monotonous nature of the job makes it a difficult and expensive task, and there is no absolute assurance that the precipitator is working at its best.

Automatic controls have superseded hand operation because, regardless of the need for constant or periodic changes or large or small voltage variations in a precipitator, they have proved to be more efficient and economical than the human operator. Automatic controls are the most efficient for a number of reasons:

As power is increased in a precipitator, its efficiency is increased until it reaches a point where it levels off. At this peak efficiency, numerous sparks jump from the charging wires to the collecting plates.

Whenever a spark occurs, there is an instantaneous reduction in precipitator and rectifier voltage. As shown in Fig. 1, this reduction also causes a temporarily greater voltage flow to the reactor placed in series in the supply line, and raises potential across the reactor.

These voltage changes in the reactor depend upon the size and strength of the spark and, when added together in a summing circuit, they produce a signal which is directly proportional to the average sparking current.

This signal of the average sparking current can then be compared to the desired average and, by means of a silicon transistor and a magnetic amplifier, power is regulated to the reactor. The reactor in turn automatically adjusts the power to the precipitator at the best level.

Automatic controls have solved several problems. Many electrical precipitators perform well when random sparking occurs as shown in Fig. 2, but these precipitators do not work well when sparking occurs in clusters; that is, one spark causing several others in rapid succession. Problem in this case is that manual control overly reduces the voltage when clusters occur, and this in turn reduces the precipitator's collection efficiency.

The solution is a special fast spark-quenching action by automatic controls, which prevents clusters by reducing the power input for a few milliseconds. This instantaneous power reduction not only prevents clusters, but is so fast that collector efficiency is almost unaffected.

Entire sequence of the spark-quenching action takes about eight cycles or 130 milliseconds, which is sufficient to prevent spark clusters on any precipitator. Shorter periods can be set if necessary to effect maximum efficiency according to the need of any specific precipitator.

Automatic controls also keep the precipitator at peak performance, even with wide changes in the type of gas or dust flowing into it. Complete full-range control of spark intensity and spark clusters is maintained with no manual adjustments needed despite the worst conditions.

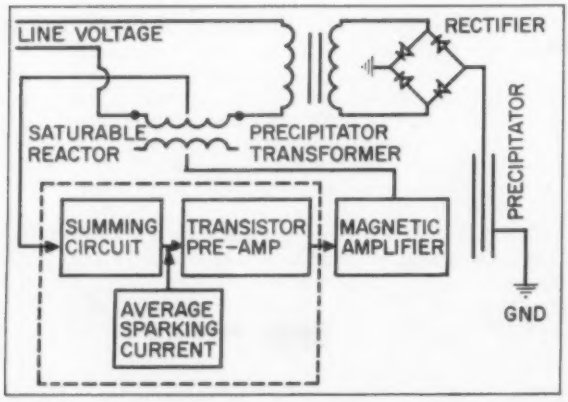
Automatic control system is virtually foolproof. There are no moving parts to wear out and no filaments to burn out. All elements are rugged and long-lived, including transformers, silicon parts, and oil-filled capacitors. Conservative design with long maintenance-free life is the principal feature of the system. All questionable parts or materials have been eliminated and small parts subject to corrosion and damage are sealed.

A good automatic power control system works best, obviously, when the precipitator is in top condition. Such things as well-designed collecting surfaces, rappers with proper impact to clean the surfaces, electrodes with adequate charge, and an even gas distribution contribute to peak performance year after year.

Field tests have proved the practical value of automatic controls. On a typical fly ash precipitator with an automatic power control, the average power input was approximately 3½ times that achieved with manual control. This meant that the precipitator was vastly more efficient while the automatic controls were at work, yet sparking was held to a minimum.

Similar tests on open-hearth steel furnaces over a period of two years have confirmed the value of automatic controls in the steel industry. In all there are over 200 automatic controls at work today on precipitators in such varied applications as fly ash, cement, chemicals, paper making, and metals. THE END

* Research & Development Engineering Dept, Western Precipitation Corp



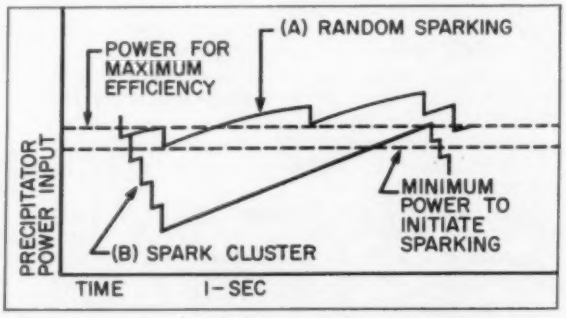


Fig. 1 (Left). Block diagram showing how an automatic power control system works. Fig. 2 (Above). Curve showing efficiency when sparking is in clusters and when it is controlled

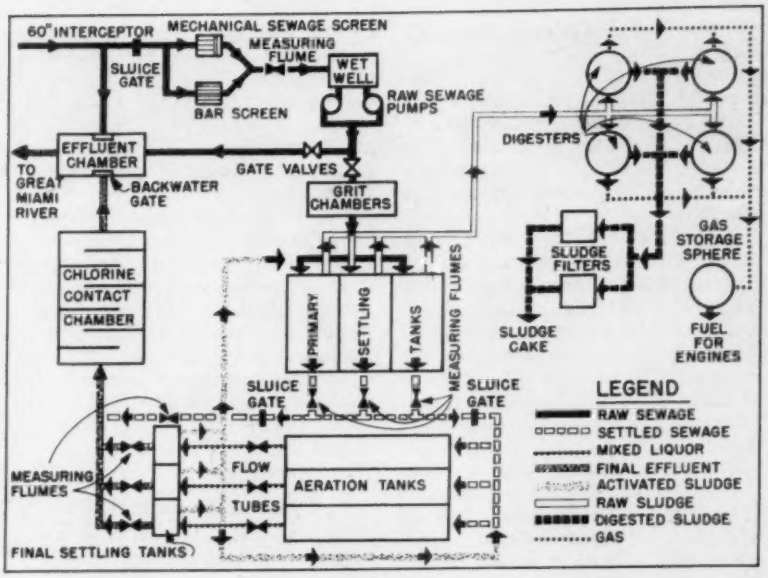


Fig. 1. Gas produced in the digesters of Hamilton's new sewage treatment plant is economically used as fuel for the diesel engines that drive the aeration blowers (Fig. 2), and also for the raw sewage pumps and sludge heaters. This plant is of the split activated sludge type, is designed for an average flow of 12 mgd, adequate until 1970

Hamilton Plant Uses Sewage Gas for Power

ONE OF THE nation's newest and most modern plants for sewage treatment was dedicated in Hamilton, Ohio, last summer. This $3,100,000 plant will serve a community of about 70,000.

Among the many pieces of intricate machinery that will process up to 18 mgd and reduce solids to less than two per cent are two Superior natural gas engines, built and installed by the White Diesel Engine Division of The White Motor Co.

Designed to meet the plant's greatest single power requirement, these two 6G-825's are rated at 300 bhp at 690 rpm each and drive Chicago Pump Co's Read Standard Blowers with a total capacity of 14,000 cfm to aerate the sewage during treatment.

Aeration aids in the formation of activated sludge that teems with aerobic organisms which feed on all the organic matter present. Aeration takes place in special tanks located between the primary and final settling tanks and also in the grit chamber. In this latter case, air provides the velocity that keeps light organic material in suspension while allowing the heavier inorganic material to settle.

As a practical economy move, the engines operate on the same gas that is a by-product of the treatment process, easing the burden of the city's taxpayers with savings amounting to thousands of dollars a year. This technique has proved beneficial to many communities in the 50,000–100,000 population category.

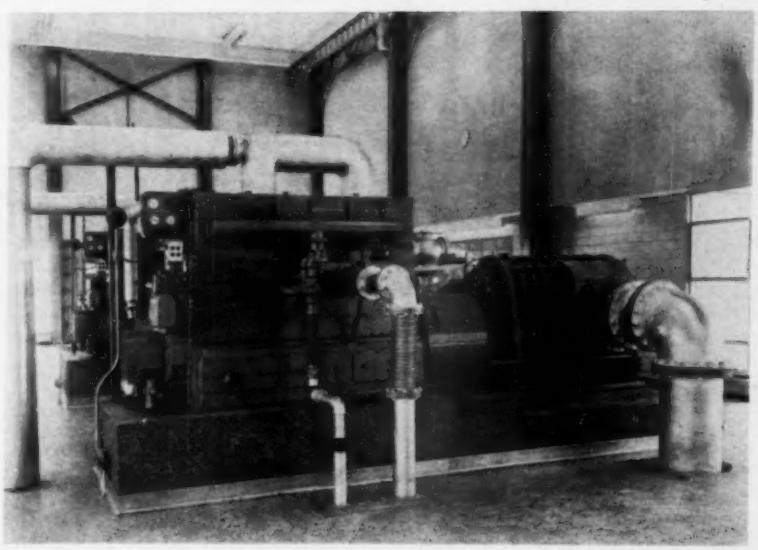


Fig. 2. Inside the main equipment building—gleaming chrome, aluminum, coördinated colors and the two big White Superior 6G-825's that drive the blowers

Gas — chiefly methane and carbon dioxide — is produced in the digesters as the result of sludge digestion. Quantities in excess of immediate demand are transferred to a 120,000-cubic-foot storage sphere on the premises for future use. This gas serves not only as fuel for the blower engines but also for the engines driving the raw sewage pumps and sludge heaters, thus supporting about 75 per cent of the plant's total power demand.

Further economy is won by using the heat transferred from the cooling water of the various engines as the major source of heat for the buildings.

Hamilton is located about 25 miles north of Cincinnati on the Great Miami River. Ohio is one of eight states that banded together to form the Ohio River Valley Sanitation Commission to enforce waste disposal, and since the Great Miami is one of the Ohio's major tributaries, Hamilton's new plant is in harmony

with the Commission's anti-pollution aims.

First step in the system's construction was the retention of the Chicago consulting engineer firm of Consoer, Townsend and Associates in 1949 to review the city's sewerage projects and supervise construction efforts.

Second step was the completion in 1954 of a dual-barrel sanitary and industrial waste intercepting sewer, ranging from 42 in. to 60 in. in diameter, and collecting from both sides of the river. Construction began on the plant itself three years later and was officially concluded in the spring of 1959 after a period of rigid testing and trial operation.

Funds to finance this program were obtained through the issuance of general obligation bonds in 1946 and 1957, which are being amortized by revenues from a sewer service charge that became effective in January, 1957. These revenues are also paying for the operating and maintenance costs of the plant and the intercepting system.

The Hamilton plant is of the split activated sludge treatment type (whereby effluent receiving the full treatment is mixed with a certain amount of effluent from the primary settling tanks before discharge into the river), with separate sludge digestion, sludge filtering, and chlorination of effluent. It is designed for an average flow of 12 mgd, which should be satisfactory until at least 1970.

Other specifications list suspended solids at 350 ppm with expected removal of 75 per cent at the 12 mgd flow. Five-day biochemical oxygen demand (BOD) is 255 ppm with expected removal of 65 per cent at average flow.

The two raw sewage pumps have a rated capacity of 12 mgd and a maximum of 20 mgd each. They are driven by small gas engines of 175 bhp at 760 rpm.

System Characteristics

Based on the average flow, detention time in the grit chambers is 10 minutes, followed by two hours in the primary settling tanks. Detention period in the aeration tanks, based on settled flow of 6 mgd and 30 per cent return sludge, is six hours, while time in the final settling tanks at the same rate of flow is 2.8 hours. At the maximum flow of 18 mgd, detention in the system's chlorine contact chamber is 16 minutes.

With a total volume of 486,600 cubic feet, the digesters can handle a per capita 6.5 cubic feet for every Hamiltonian; 1250 pounds of digested sludge per hour is the capacity of each of the two digested sludge filters.

Raw sewage enters the treatment cycle through the 60-in. interceptor line and passes through both a bar screen and a mechanical sewage screen before dropping into the wet well. It is next pumped up 34 feet into two aerated grit chambers where the heavier inorganic materials settle out, then on to the primary settling tanks. Here settled sewage and sludge are separated, the latter moving on to the digesters, filters, and eventually disposed of in the form of sludge cakes.

Settled sewage, at the maximum rate of 9 mgd, next enters the three aeration tanks where "the bugs" go to work, then to the final settling tanks. By this time the effluent is about 95 per cent pure. During low river stage it may pass through the chlorine contact chamber on its last stop before discharge into the river, but normally it would move right from final settling to river. THE END.

U. S. Group Participates in World Power Conference

THIRTEEN technical papers relating to methods of solving power shortage problems have been submitted by United States representatives for the 13th biennial sectional meeting of the World Power Conference to be held in Madrid, Spain, June 5 to 9, 1960.

Authors of the 13 American papers include: C. C. Anderson and T. W. Hunter of the U. S. Bureau of Mines; Floyd E. Dominy, Bureau of Reclamation; Arthur S. Griswold and F. Douglas Campbell, Detroit Edison; Philip Sporn and S. N. Fiala, American Electric Power Service Corp.; Joseph K. Dillard, Westinghouse; John W. Leslie, U. S. Corps of Engineers; Karl B. Nagler, Peoples Gas Light & Coke; Walker L. Cisler, Detroit Edison; Edgar T. Hughes and Norman C. Nelson, Federal Power Commission; P.A. Abetti and I.B. Johnson, General Electric; Frank E. Pittman, AEC; Walter H. Zinn of Combustion Engineering, and Joseph R. Dietrich, General Nuclear Engineering Corp; C.C. Whelchel, Pacific Gas and Electric.

The papers were sponsored by the United States National Committee. The U. S. group is one of 55 national committees from all over the world making up the membership in the World Power Conference, a non-government international organization with headquarters in London, England. In addition to the biennial sectional meetings, plenary sessions are held once every six years.

Long-Term Power Needs

Using the subject, Methods of Solving Power Shortage Problems, the general theme of the Madrid conference will stress the long-term rather than short-term supply of a country's energy needs. This principal theme will be discussed under subdivisions dealing with methods of investigation of energy sources and requirements; efficiency of production and utilization of energy; technical developments in transportation of fuels and transmission of electrical energy; establishment of nuclear reactors on an industrial scale; and functional interrelation between conventional and nuclear production of energy.

Papers will be printed and distributed to each registrant well in advance of the Madrid conference date, so that the session may be conducted on a discussion, or workshop, basis rather than with formal presentations of the complete papers.

There will be post-conference tours including visits to power installations, industrial plants, and points of interest throughout Spain.

All WPC participants must register through their national committees. U. S. engineers should write to the United States National Committee requesting registration forms, which must be returned to the Secretary with the conference $50 registration fee.

The secretariat for the U. S. Committee is furnished through the Engineers' Joint Council, 29 W. 39th Street, New York 18, New York. All communications should be directed to the Secretary, U. S. National Committee, World Power Conference, at that address.

The U. S. Committee, which is managed by an executive board of nine members, has also announced the election of its officers to serve for the ensuing year. They are: Francis L. Adams, Chief, Bureau of Power, Federal Power Commission, chairman; James N. Landis, vice-president, Power Division, Bechtel Corp, vice-chairman; and Brig. Gen. Stewart E. Reimel, U. S. A. (Ret.), secretary.

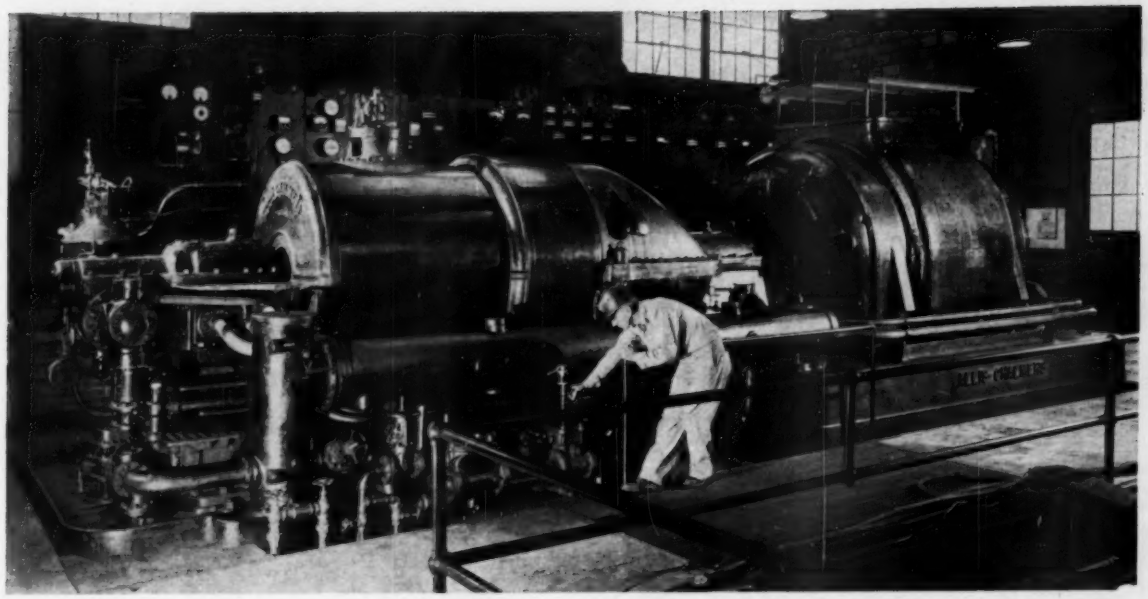


Fig. 1. Older generating equipment like this 3000-kw unit can often continue to meet requirements under new conditions

Changing Steam Conditions?

Don't Count Your Old Turbine Generator Out

Changing steam conditions in a process plant doesn't necessarily mean discarding existing generating equipment with many years of serviceability left. Here's how conversion may be accomplished

By ROBERT THORESEN *

IT SHOULD BE gratifying to a power operating engineer to know that system changes need not necessarily make the power plant's equipment obsolete.

If, for example, a new boiler, modification of the steam cycle, or a change in a plant process is contemplated, it is possible that the existing turbine-generator unit could continue to meet limited, or in some cases, full requirements even under the new conditions.

While a steam turbine-generator unit is designed for maximum efficiency operation at certain specified steam conditions, it is quite possible that the materials, bolting, and stress levels incorporated in the design will permit its operation at other conditions. Any appreciable change in steam conditions will, however, affect the performance of the unit in varying degrees depending upon its type and amount of change.

Here is a simplified method for estimating output and steam rates with changed steam conditions for most of the several types of existing steam turbine-generator units.

Procedure used in making calculations to obtain revised performance figures should be as accurate as possible without being excessively detailed or complicated, since only approximate results are needed. Where the estimated output and steam rates with the changed conditions appear to meet the requirements of the changed cycle, process, or other revision, it is wise to consult the manufacturer on the adequacy of bolting, materials, internal stresses, and the possibility of limited modifications to operate with the changed conditions.

Possible Changes

Changes possible with most units:

1. Condensing unit (to operate condensing with changed steam conditions).

2. Condensing unit (to operate non-condensing with changed steam conditions).

3. Non-condensing unit (to operate non-condensing with changed steam conditions).

4. Condensing automatic extraction unit (to operate straight condensing with changed steam conditions).

5. Condensing automatic extraction unit (to operate straight non-condensing with changed steam conditions).

6. Non-condensing automatic extraction unit (to operate straight non-condensing with changed steam conditions).

7. For any changes in the steam conditions of an automatic extraction unit which will continue to be used as an automatic extraction unit, it is suggested that the manufacturer's engineering department be consulted.

For simplification and time saving, the method does not directly include such factors as the age and condition of the unit, the increased leaving loss caused by the reduced throttle flow (this is a result of changed steam conditions in most cases), and the change in machine efficiency due to the change which usually takes place in the velocity ratio. To adequately compensate for these missing factors,

*Application Engineer, Steam Turbine Dept, Allis-Chalmers Mfg Co

an arbitrary five per cent is added to the revised steam rates.

While it is impossible to state all the limits which would apply to all possible changes in steam conditions for all turbines, detailed calculation procedures for variations which may be proposed and which are listed above follow:

1. Condensing unit (to operate condensing with changed steam conditions).

A. Determine maximum rated throttle flow and contract steam rate at 100 per cent load with contract steam conditions.

B. By ratio of theoretical availables, calculate the steam rate at 100 per cent rating for the changed steam conditions.

$$100\%\ \text{contract steam rate} \times \frac{(h_1 - h_2)1}{(h_1 - h_2)2}$$

Where:

$(h_1 - h_2)1$ = Available with contract steam conditions

$(h_1 - h_2)2$ = Available with changed steam conditions

C. Using the revised steam rate for 100 per cent load obtained in Step B, multiply by the load factors from the accompanying tables to obtain the revised steam rates at other loads. Use the load factor for the changed steam pressure and changed exhaust condition from the table corresponding to 100 per cent contract rating.

D. Add five per cent to the rates obtained in Step C to cover age and condition of the unit, increased leaving losses, and change in velocity ratio.

E. Calculate revised throttle flows for each load using steam rates from Step D, and draw a curve of throttle flow vs kw load.

F. Calculate the maximum throttle flow with the changed steam conditions using the following formula:

$$W_2 = W_1 \frac{P_2}{P_1}\sqrt{\frac{P_1 V_1}{P_2 V_2}}$$

Where:

W_1 = Maximum rated contract throttle flow

W_2 = Maximum revised throttle flow

P_1 = Contract throttle pressure

P_2 = Changed throttle pressure

$P_1 V_1$ = Contract PV product

$P_2 V_2$ = Revised PV product

G. The maximum throttle flow with the changed steam conditions found in Step F will determine the approximate kw output possible with the changed steam conditions on the curve drawn in Step E.

H. Throttle flows and steam rates for fractional loads less than the maximum load obtainable with the revised throttle flow may be taken from the curve drawn in Step E.

2. Condensing Unit (to operate non-condensing unit with changed steam conditions).

A. Determine maximum rated throttle flow and contract steam rate at 100 per cent load with contract steam conditions.

B. By ratio of theoretical availables, calculate the steam rate at 100 per cent rating for changed steam conditions.

$$100\%\ \text{contract steam rate} \times \frac{(h_1 - h_2)1}{(h_1 - h_2)2}$$

Where:

$(h_1 - h_2)1$ = Available with contract steam conditions

$(h_1 - h_2)2$ = Available with changed steam conditions

C. Using the revised steam rate for 100 per cent load obtained in Step B, multiply by the load factors from the accompanying tables to obtain the revised steam rates at other loads. Use the load factor for the changed steam pressure and changed exhaust conditions from the table corresponding to 100 per cent contract rating.

D. Add five per cent to the rates obtained in Step C to cover age and condition of the unit, increased leaving losses, and change in velocity ratio.

E. Calculate revised throttle flows for each load using steam rates from Step D, and draw a curve of throttle flow vs kw load.

F. Calculate the maximum throttle flow with the changed conditions using the following formula. (The pressure limitation on the exhaust end seal should be checked with the manufacturer.)

$$W_2 = W_1 \sqrt{\frac{P_{T_2}^2 \quad P_{E_2}^2}{PV_{T_2} \quad PV_{E_2}} \Big/ \frac{P_{T_1}^2 \quad P_{E_1}^2}{PV_{T_1} \quad PV_{E_1}}}$$

Where:

W_1 = Maximum rated contract throttle flow

W_2 = Maximum revised throttle flow

P_{T1} = Contract throttle pressure

P_{T2} = Changed throttle pressure

P_{E1} = Contract exhaust pressure

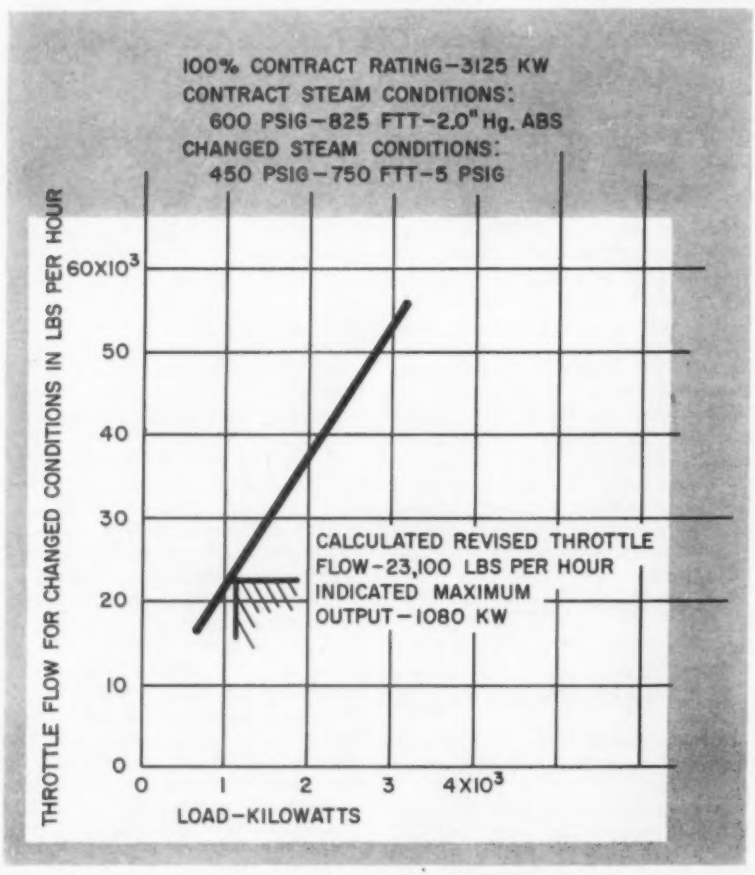


Fig. 2. Throttle-flow curves like this show performance under new conditions

Data sheets like this can help determine older unit performance under new conditions. For a complete set, write the editors

Initial Steam Pressure Psig	3750 KW MAX. RATED ① Exhaust Pressure—in. Hg abs						5000 KW MAX. RATED ① Exhaust Pressure—in. Hg abs					
	1.50	1.75	2.00	2.50	3.00	4.00	1.50	1.75	2.00	2.50	3.00	4.00
Table C — Load Factors												
20% Rated Load, 0.80 Pf												
100	1.252	1.259	1.265	1.273	1.279	1.286	1.244	1.251	1.257	1.267	1.271	1.277
200	1.235	1.241	1.246	1.253	1.257	1.262	1.228	1.234	1.238	1.245	1.249	1.254
400	1.223	1.228	1.232	1.237	1.241	1.244	1.216	1.221	1.225	1.230	1.233	1.237
800	1.215	1.218	1.221	1.225	1.228	1.231	1.208	1.212	1.214	1.218	1.221	1.224
40% Rated Load, 0.80 Pf												
100	1.076	1.079	1.081	1.085	1.088	1.091	1.074	1.077	1.079	1.085	1.085	1.088
200	1.071	1.074	1.076	1.079	1.081	1.083	1.069	1.072	1.074	1.076	1.078	1.080
400	1.068	1.070	1.072	1.074	1.075	1.077	1.066	1.068	1.070	1.072	1.073	1.074
800	1.066	1.068	1.069	1.071	1.072	1.073	1.064	1.066	1.067	1.069	1.070	1.070
60% Rated Load, 0.80 Pf												
100	1.023	1.024	1.025	1.027	1.027	1.028	1.022	1.024	1.024	1.026	1.027	1.028
200	1.021	1.022	1.023	1.024	1.025	1.026	1.021	1.022	1.022	1.024	1.024	1.025
400	1.020	1.021	1.022	1.022	1.023	1.024	1.020	1.020	1.021	1.022	1.022	1.023
800	1.020	1.020	1.021	1.021	1.022	1.022	1.019	1.020	1.020	1.021	1.021	1.022
80% Rated Load, 0.80 Pf and Rated Load, 1.0 Pf												
All	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

P_{E_2} = Changed exhaust pressure
PV_{T_1} = Contract throttle PV product
PV_{T_2} = Changed throttle PV product
PV_{E_1} = Contract exhaust PV product
PV_{E_2} = Changed exhaust PV product

G. The maximum throttle flow with changed steam conditions found in Step F will determine the approximate kw output possible with the changed steam conditions on the curve drawn on Step E.

H. Throttle flows and steam rates for fractional loads less than the maximum load obtainable with the revised throttle flow may be taken from the curve drawn in Step E.

3. Non-Condensing Unit (to operate non-condensing with changed steam conditions). The procedure to be followed for this change is identical to procedure No. 2.

4. Condensing Automatic Extraction Unit (to operate straight condensing with changed steam conditions). Determine the maximum rated throttle flow and contract steam rate at 100 per cent load when operating straight condensing with contract steam conditions. Using these figures, the revised output and steam rates may be determined according to procedure No. 1.

5. Condensing Automatic Extraction Unit (to operate straight non-condensing with changed steam conditions).

If the rated extraction pressure of the turbine is high and the changed exhaust pressure is within the manufacturer's limitation, determine the maximum rated throttle flow and contract steam rate at 100 per cent load when operating straight condensing with contract steam conditions. Using these figures, the revised output and steam rates may be determined according to procedure No. 2. If the changed exhaust pressure is in the same range as, or higher than, the rated extraction pressure, determine the capacity of the non-condensing turbine in the automatic extraction unit by the maximum point on the maximum extraction line. Using the throttle flow and kw capacity at this point as the rated contract conditions, the output and throttle flow for the changed conditions may be determined according to procedure No. 2.

If it is not immediately apparent which of the above methods applies, it may be necessary to use both to determine which provides maximum output.

6. Non-Condensing Automatic Extraction Unit (to operate straight non-condensing with changed steam conditions).

The maximum throttle flow to use in this case will be determined by the changed exhaust pressure. If the changed exhaust pressure is the same as, or close to the contract exhaust pressure, determine the maximum rated throttle flow and contract steam rate at 100 per cent load when operating straight non-condensing with contract steam conditions. If the changed exhaust pressure is the same as or close to the contract extraction pressure, determine the maximum throttle flow and kw capacity by the maximum point on the maximum extraction line.

Using the throttle flow and kw capacity from either of the above methods as rated contract conditions, the output and throttle flow for the changed conditions may be determined according to procedure No. 2.

7. Automatic Extraction Unit (to operate automatic extraction with changed steam conditions).

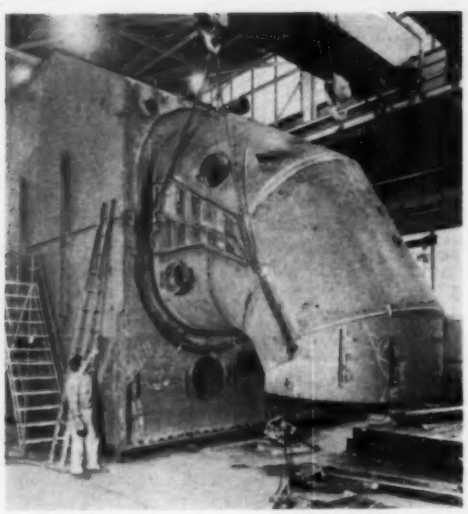
While this method to determine output and steam rates with changes in steam conditions is suitably accurate, it should be remembered that it is intended only for estimating purposes and as such will be more accurate in some cases than in others. In the case of increased pressure and temperature, design and material limitations must be checked and any other results of changes in steam conditions, such as increased thrust, must be considered individually. For example, Allis-Chalmers condensing turbines with water-sealed glands, when operated as non-condensing units, should be limited to a back pressure of 8 psig to assure minimum leakage and maintenance. Whether or not the changes may be feasible is up to the engineer's judgment, but if there is any reason to doubt that the changes in steam conditions are practical, it would be wise to consult with the manufacturer. THE END

POWER ENGINEERING'S NEWS REEL

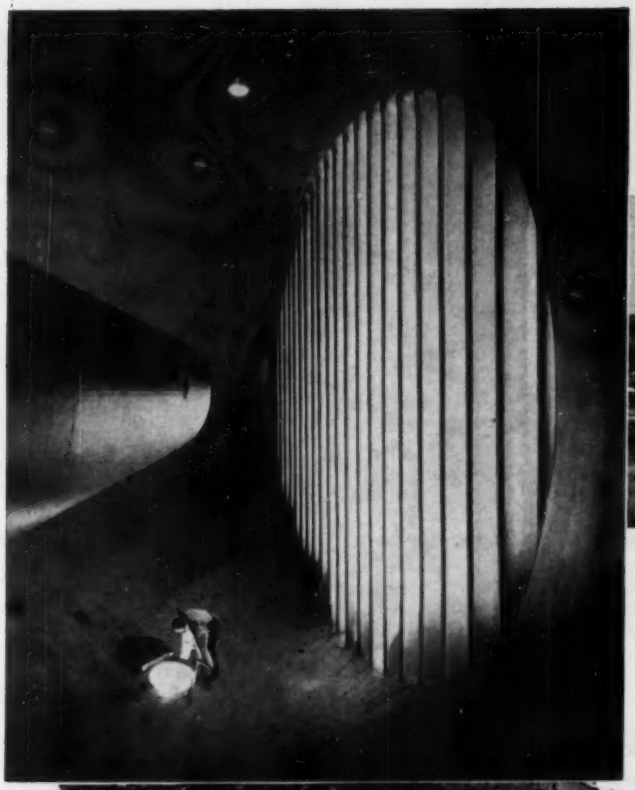
Bill Kling (right) of Allis-Chalmers explains to Dick Morris of POWER ENGINEERING the construction of 12 impeller-runners to be used on Tuscarora pumped storage project. Left is Rodney Bond of A-C's York, Pa., plant

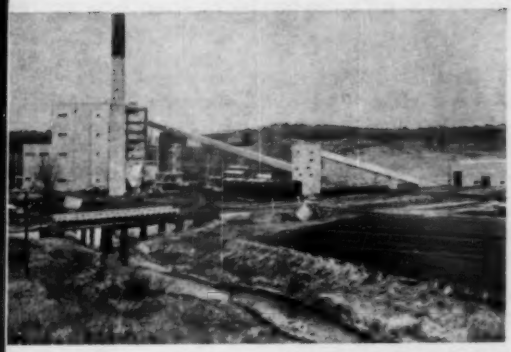
Nuts and bolts to hold an hydraulic turbine together. Total of 476 of these are used in seven Allis-Chalmers 140,000-hp turbine units built for hydroelectric project in Washington

Yankee Atomic's nuclear power plant at Rowe, Mass., will use fuel units like this one getting its final inspection at Westinghouse. About 8 ft long, the element contains 150 pellets of slightly enriched uranium oxide



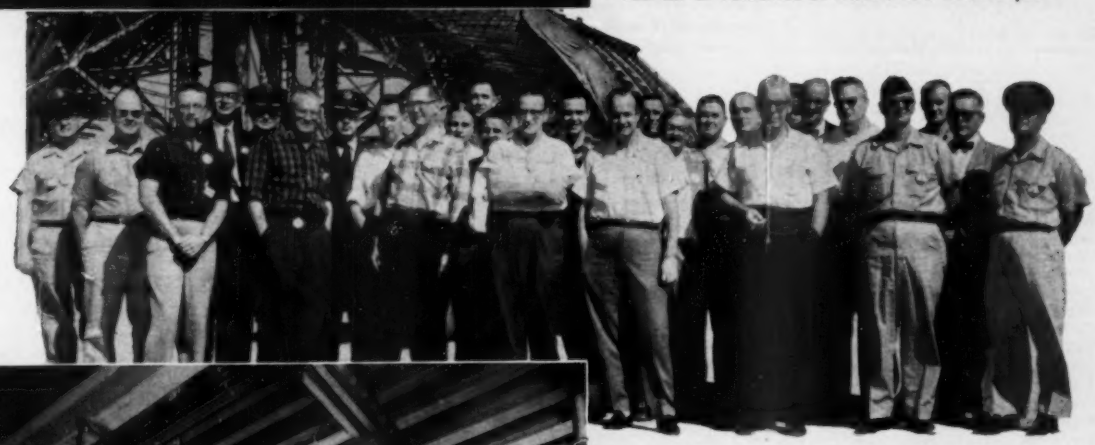
110,000 sq ft surface condenser was completely fabricated at factory and aligned into shell components before shipment by American-Standard to Louisiana's Little Gypsy station. Condenses 1,410,000 lb/hr of steam, back pressure 2.65 in. Hg



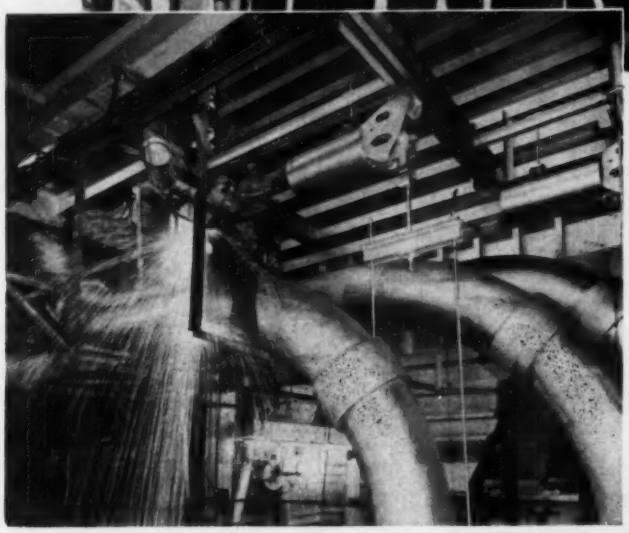


53,500-kw turbine generator has been added to Otter Tail Power Co's Hoot Lake plant in Fergus Falls, Minn. Station burns over 1000 tons of low-cost N. Dakota lignite a day

Inside huge propulsion wind tunnel at Arnold Engineering Development Center in Tenn. Giant Westinghouse compressors will drive test air at velocities of from 1000-3000 mph



At Cape Canaveral, group of editors of technical magazines tours the missile base on invitation of Maj. Gen. Minton, director of Air Force facilities. Host on trip was Brig. Gen. Curtin. POWER ENGINEERING's editor, Bob McCaw, is third from the right in front row



Main steam and hot and cold reheat lines serving the first 170,000-kw turbine generator to be installed at new Stratton, Ohio, plant of Ohio Edison. Dravo Corp made this heavy chrome-moly piping, thickness to 3 in.

Maintenance Tips on Transformers

This final article in a set of three on transformers discusses how to plan for periodic tests and inspections, what to look for, how to detect and repair leaks, and how to recondition flooded units

By A. J. BECKER*

PERIODIC field inspection after installation of the transformer is a good practice. Extent of this inspection and maintenance program is governed by size, voltage, type of service, location of system, operating conditions, and contaminating possibilities. For liquid- and dry-type transformers, maintaining high insulation strength is of utmost importance. Inspection should consist of insulation resistance tests on bushings and windings. Schedule should include check of liquid level, temperature and pressure gages.

Periodic oil tests are an effective means of predicting maintenance requirements of any liquid-filled transformers. Dielectric tests may offer a clue to possible trouble spots.

Porcelain bushings, although somewhat fragile, are not generally a source of trouble if properly installed and maintained. A regular program of inspection and testing is useful in maintaining top service continuity. Important objectives are defects and breakage in the form of cracks, chips, surface contamination, and deterioration of organic insulations used in some assemblies. Additional inspections should be made for surface tracking, loose connections, corrosion and liquid or gas leakage. Insulation resistance or watt loss measurements are recommended for seeking out weakness or insulation deterioration.

There are many types of gasket materials in use as liquid and gas seals or for weatherproofing. Most are good when specifically designed for a particular job and when properly installed. When a gasket joint is not sealed properly, further tightening is seldom the solution.

Best results are usually obtained by replacing the gasket, providing an investigation indicates that a different type or size of gasket is required. Some gaskets require cement to hold them in proper position. If cements are used, always be sure the gasket material is compatible with the cement.

Since the life of the transformer far exceeds the protective ability of the exterior paint, the maintenance schedule should include inspection touch-up plus periodic painting.

Proper preparation of the surface is most important for a lasting job. Washing and cleaning with detergents, hot caustics or sandblasting methods are used. Since each layer of paint adds insulation, it naturally retards heat dissipation; therefore, if the coating is too heavy, it should be stripped. The three basic methods of paint application are brushing, spraying and flow-coating. Flow-coating is the best method for reaching complex tubes or hidden parts.

Color and type of paint should be determined by the installation location, particularly for the final coat. Generally the non-metallic finish will give the most satisfactory over-all thermal performance. Most paints add 0.001-in. thickness per coat. A total film thickness of 3 mils properly applied should give surface protection for 10 years.

Leak Detection and Repair

It is extremely important that all leaks in a transformer be repaired as soon as possible. Several methods are recommended to detect leaks, depending on whether the leak is below or above the liquid level, and the type of oil preservation equipment that is used.

For leaks above gas space: 1. locate with soap-water and pressure; 2. use a Halogen leak detector; 3. fill gas space with oil — use a stand pipe or expansion tank for a head of oil.

Leaks below the liquid level can be pinpointed by using powered

Here's a tabular checklist to use in setting up periodic transformer inspection

	Oil Immersed Power						Other Types					
	Free Breathing	Conservator	Sealed	Gas-Oil Sealed	Positive Pressure	F. O. Cooled	Water-Cooled	Distribution	Instrument	Askarel-Filled	Ventilated Dry	Sealed Dry
Ambient temperatures*	H	H	H	H	H	H	H	—	—	H	H	H
Liquid temperatures*	H	H	H	H	H	H	H	—	—	H	—	—
Water temps, in & out*	—	—	—	—	—	—	H	—	—	—	—	—
Winding temperatures*	H	H	H	H	H	H	H	—	—	H	H	H
Liquid levels*	H	H	H	H	H	H	H	A	A	H	—	—
Water flow, in & out*	—	—	—	—	—	—	H	—	—	—	—	—
Current (load)*	H	H	H	H	H	H	H	—	—	H	H	H
Voltage*	H	H	H	H	H	H	H	—	—	H	H	H
Pressure/vacuum gage*	—	—	H	—	H	—	—	—	—	H	—	D
Pressure relay	—	—	SA	SA	SA	SA	—	—	—	—	—	—
Pressure relief diaph.	—	SA	SA	SA	SA	SA	M	—	—	SA	—	—
Breathers (dehydrating)	M	M	—	—	—	—	M	—	—	—	—	—
Liquid test	A	A	A	A	A	A	A	5Y	5Y	A	—	—
Oxygen analysis	—	—	—	Q	A	—	—	—	—	—	—	A
Trans. Nitrogen Pressure	—	—	—	SA	SA	—	—	—	—	—	—	A
Nitrogen cyl. pressure	—	—	—	—	W	—	—	—	—	—	—	—
Transf. P. F. tests	A	A	A	A	A	A	A	—	—	A	A	A
Bushing P. R. tests	A	A	A	A	A	A	A	—	—	A	—	A
Insul. resistance (Megger)	A	A	A	A	A	A	A	—	—	A	A	A
F. A. fan lubrication	A	A	A	A	A	A	—	—	—	A	SA	—
F. A. fan controls	M	M	M	M	M	M	—	—	—	M	M	—
Tap changers (deenerg.)	A	A	A	A	A	A	A	A	A	A	—	—
Tank finish (paint)	A	A	A	A	A	A	5Y	5Y	A	A	5Y	5Y
Ground resistance	A	A	A	A	A	A	A	A	A	A	A	A
Pump glands	—	—	—	—	—	W	W	—	—	—	—	—
Gas absorbers	—	—	—	—	—	—	—	—	—	SA	—	—
Inspection under cover	A	5Y	5Y	5Y	5Y	5Y	A	A	—	5Y	—	—
Complete external insp.	A	A	A	A	A	A	A	2Y	10Y	A	A	A
Complete internal insp.	10Y	10Y	10Y	10Y	10Y	10Y	A	5Y	—	10Y	SA	—

*The inspection rate or frequency indicated here is suggested primarily for attended stations where the attendant or operator is required to log this data periodically. Unattended, automatic or remote-controlled stations should have these items checked once each week.

LEGEND

H—Hourly
D—Daily
W—Weekly
M—Monthly
Q—Quarterly
SA—Semi-annual
A—Annually
2Y—2 years
5Y—5 years
10Y—10 years

* Service Engineer, Allis-Chalmers Mfg Co, Pittsburgh Works

chalk or applying acetylene smoke. Gasket leaks can seldom be resealed; it usually pays to replace the gaskets. Weld leaks can be repaired with cold or hot solder, epoxy resins, or electric welding, but a back pressure or vacuum is necessary if the leak is below the liquid level. Weld any leaks in the gas space or above liquid level only after venting all oxygen and purging with a steady flow of nitrogen at low pressure while welding. This is also recommended if a welded-on cover is burned off.

Flooded Transformers

Reconditioning of flooded transformers begins with external cleaning, inspection of the equipment to determine the extent of the damage, and a preliminary examination of the cooling liquid.

Nature and extent of the damage should be studied before much time and labor have been spent in attempting to dry and recondition transformers. Units that have been flooded during a fire can be reconditioned by methods outlined here, if not otherwise damaged by heat or fire extinguishing chemicals.

Compound-filled units such as current and potential transformers can become water-logged due to flood waters seeping into the compound through small checks or cracks in the material. Since it is very difficult for moisture to escape from these units, it is often more expedient and economical to remove the compound and the element from the case and dry the element separately by external heat.

Reactors, motor starters, auto transformers, distribution transformers, and load center dry-type units should preferably be removed from the case, and the element cleaned and dried before retanking.

Varnish-treated or impregnated windings create less of a drying problem than untreated windings. A more thorough inspection should be made of untreated insulation, since the hard surface and the dielectric strength of insulating papers become impaired by prolonged immersion in water.

Most askarel-filled transformers, and some oil-filled transformers are completely sealed and therefore not easily flooded. However, if the external parts of the equipment, such as valves, liquid or temperature gages, and relief diaphragms or bushings, are damaged, there may be some leakage.

Askarel, unlike conventional insulating oil, is not displaced by water. Therefore, a leak above the normal liquid level will make it possible to drain most of the water off the top. The remaining liquid should be salvaged by filtering, if such a step is practical. Filtering should continue until the askarel reaches a dielectric strength of 22 kv. Core and coil element should be removed from the tank and the mud and silt deposit flushed away.

If the insulating oil has been partially or entirely displaced by flood water, it should be drained through the bottom drain outlet and discarded. In cases where only a small amount of water has entered the tank, it may be practical to salvage the insulating oil. To do this, first place the oil in a container and allow foreign matter to settle, then filter the oil until a dielectric strength of at least 22 kv is reached.

After draining the tank, remove the core and coil element and flush the element with hot water under pressure. Water temperature should not exceed 150 F and the maximum pressure should be 40 psi.

Wash down the tanks thoroughly. Removable radiators should be disassembled and thoroughly flushed with hot water.

Water cooling coils should be cleaned with a muriatic acid solution, with equal parts of C.P. hydrochloric acid and water (1.10 specific gravity is required). Allow this to stand in the water coils for at least one hour. Flush coils with clear water.

Caution: To prevent injury to workers, make certain that rubber gloves and protective goggles are worn when muriatic acid is used. Keep cold fresh water handy to flush off any acid accidentally spilled. Only workers familiar with using acid should be allowed to do this cleaning.

Before being put back into operation, the cooling coils must withstand a pressure test of at least twice the required operating pressure.

Drying the Core and Coils

Several methods are reliable when drying the core and coils of flooded transformers. If the drying-out process is performed incorrectly and not carefully thought out, great damage can result from fire, overheating, or internal pressures, the latter caused by rapidly formed steam in the windings.

External heat method is preferable for drying flooded core and coil elements. Equipment for supplying this heat is varied. Steam coils or temporary piping can be used. Boilers and railroad steam engines have been utilized. Industrial ovens can also be adapted.

If these facilities are not available, portable ovens or enclosures can be built as temporary housings for drying the core and coil elements. Skeleton frames, of lumber or steel angles, covered with any suitable fireproof material can be adapted for the temporary oven enclosure. Vacuum tanks, where available and large enough to house the unit being dried, are highly recommended and will expedite the reconditioning program. Here, again, care must be exercised in applying the vacuum.

Hot-air furnaces are another source of dry heat. Where electric power is available, infra-red heat lamps are

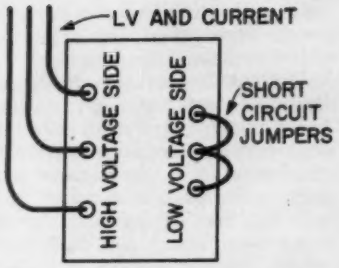


Fig. 1. Drying out by passing low voltage and current through high voltage side, low voltage coils short-circuited

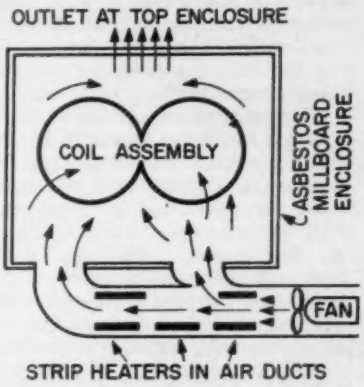


Fig. 2. Forced hot air method of dry-out

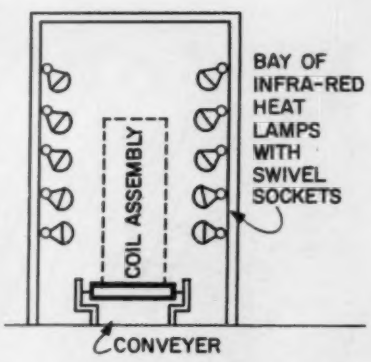


Fig. 3. Heat lamp method of drying-out

valuable heating elements since they can be directed at any angle, with swivel sockets.

Dry-out temperature readings of the core and coils are essential. Measurements should either be taken by recording thermometer, thermocouples or by a thermometer whose bulb is inserted at a point in the windings that will indicate an average temperature, and the dial face of which is easily readable outside the oven heater. Temperature instruments of this type will not only save time in taking readings, but will also eliminate the necessity of opening the drying ovens, thus preventing unnecessary changes in oven temperatures and loss of heat. A log of temperature is essential, particularly for control, but also for plotting megger curve of the dry-out run.

Megger readings of insulation resistance are of value, particularly as an indication of the condition and progress of the drying cycle. However, these tests can be relied upon only when the transformer is without oil. Convenient connections to the terminals and ground of the core and coil element should be made and the marked leads brought out of the oven or housing for periodic readings.

Usually completely flooded coils will show a short circuit or a megger reading too low to be read on initial test before drying has begun. Carefully check this resistance during the first two or three hours of drying, to prevent damaging the coils with the test instrument voltage. Usual procedure suggests megger readings of high voltage to low voltage and ground, low voltage to high voltage and ground, and high voltage and low voltage to ground.

Keep a log, so these readings can be plotted on graph paper to indicate the trend. Readings should be taken hourly and the drying continued until constant for at least 12 hours without change in temperature. Insulation resistance in megohms varies inversely with the temperature, and for a 10 C change in temperature the megohms will change by a ratio of approximately two to one. Thus, for a decrease of 10 C in temperature the value of the insulation resistance in megohms will be doubled.

The graph shown in Fig. 4 may be used for determining insulation resistance change with variation of temperature. For example: to find the value of insulation resistance in oil at 30 C if it is 640 megohms at 60 C, the graph is entered at 60 C on bottom scale and the vertical followed up to 640 megohms, which is on one of the oblique lines. This oblique line is followed until it crosses the 30 C vertical, giving 5000 megohms at 30 C. This graph may be used for transformers in air if the temperatures are read on the upper scale. When the resistance does not fall on one of the oblique lines, the change follows a line parallel to them.

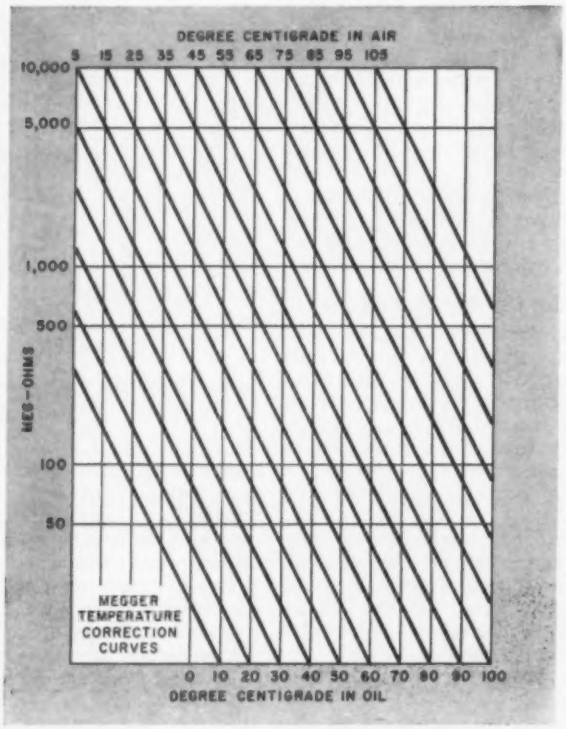


Fig. 4. Graph for determining insulation resistance change with variation of temperature. For use, see example in text

After it has been determined from the log or dry-out curve that the core and coil element is entirely dry, the unit should be thoroughly inspected to determine that all nuts and bolts are tight, and the assembly complete and in order. All copper connections should be cleaned of oxide — insulation barriers, spacers, and other insulation placed in good order, clearances checked, and any damaged lead insulation replaced or retaped.

The element should be assembled in its tank, which has been prepared properly while the element was being dried out. The assembly should be completed and the core and coil element covered with oil, preferably while still hot, or at least while the element is still above the ambient temperature (particularly on units of voltage class above 15 kv).

The insulating oil used should be filtered or replenished.

Proof tests should be performed on the reconditioned transformer.

Current Circulating Method

If the transformer has not been completely flooded, the following method may be used to dry the core and coils. This method is very slow and tedious. It should be used only for small units or when other methods are impossible.

First heat the windings and oil to a high temperature by short-circuiting one winding and applying a-c voltage to the other. Usually it is more practical to short-circuit the low voltage winding and apply voltage to the high. The voltage applied should be sufficient to produce between one-half and three-quarters of full-rated load current in the windings.

Check the nameplate for the impedance of the transformer, and determine the approximate voltage necessary to produce the desired amount of short-circuit current. If 50 per cent of rated current is desired, 50 per cent of the impedance voltage should be applied.

If oil cooling is restricted, and the current is limited to between one-half and three-quarters of full load, the temperature of the windings should not exceed the top oil temperature to such an extent that localized overheating deteriorates insulation

To limit oil cooling, close one radiator valve on a self-cooled unit or reduce the flow of the cooling fluid for forced oil- or water-cooled transform-

ers. This will allow the temperature to rise faster and limit the gradient between the oil and winding temperatures. One valve should remain open for oil expansion within the radiator. Small transformers without radiator valves may either be blanketed or dried with the oil level below the upper radiator or tube openings.

The table below shows the short-circuit current in per cent of full-rated load current which may be used in this method of drying transformers. Corresponding maximum allowable top oil temperature also is indicated. The current should circulate through the complete windings; all turns should be in the circuit.

Exceeding these temperature limits and loads will endanger the transformer. The self-cooled full-load current should be used as a basis on forced air-cooled transformers.

Short-Circuit Current in Per Cent of Full Load

Self-cooled and Water-cooled Transformers (%)	Forced Oil-cooled Transformers (%)	Maximum Top Oil Temperature (Deg C)
60	35	85
75	45	80
100	60	75

Note that the higher the allowable temperatures, the smaller the load. More blanketing of the tank or less coolant circulation is required for smaller loads in order to bring the temperature up to the points shown.

As the maximum oil temperature is approached, gradually reduce the load until a steady-state condition is reached within the above limits.

Provide good ventilation at the top of the tank so that escaping water vapor will dissipate and not condense on the underside of the cover or elsewhere in the tank. It is recommended that the cover be lagged with insulating material to insure against moisture condensation. Drying time may be shortened by filtering the oil as the moisture is driven from the insulation.

Drying should be continued until oil from the top and bottom of the tank tests 26 kv or higher. Discontinue filtering and take seven consecutive tests at four-hour intervals while keeping the oil at maximum temperature for the load held. Decrease in the dielectric strength indicates that moisture is still passing from the core and coils into the oil. Unless the tests show constant or increasing dielectric strength, filter the oil and continue the drying process.

After the short-circuit run is discontinued, energize the transformer for 24 hours at approximately two-thirds voltage at no load; then a check test should be made on the oil. If this test is satisfactory, apply full voltage at no load for 24 hours, after which the transformer may be put on the line. If additional sample tests indicate the need, refilter the oil. Apply full voltage after a satisfactory two-thirds voltage test for 24 hours and repeat the tests.

Caution: The condition of the oil is a fairly good indication of the progress made in the drying-out process. This type of check can usually be relied upon for small- and medium-sized power transformers having moderate voltage rating. However, it is an indirect indication of the condition of the solid insulation.

A log of insulation power factor and resistance readings should be taken during the drying process. Include time and temperature at which the readings are taken. THE END

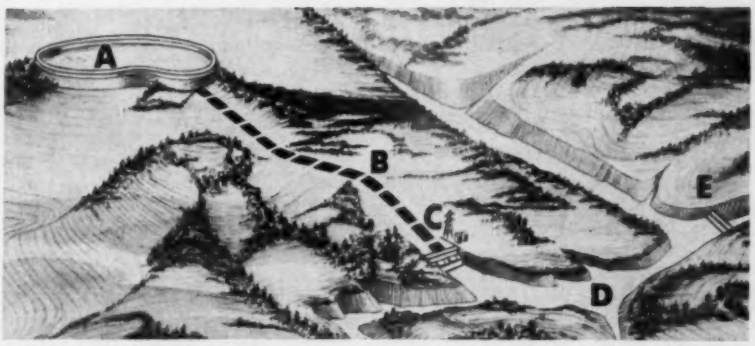
Union Electric Goes in for Pumped Storage

UNION ELECTRIC CO will build a pumped storage power plant which, including transmission facilities, will cost approximately $50,000,000. It will be built near Lesterville, Mo, as the next expansion of the power capacity for the St. Louis area. Providing an additional 350,000 kw of daytime peak capacity, the plant will be ready for service in the spring of 1963. It will be called Taum Sauk.

The project involves the creation of two small pools, one on the east fork of Black River at Taum Sauk Creek, and the other on top of a granite mountain nearby.

Combination pump-turbines using power from St. Louis area steam plants will move the water from the lower to the upper pool each night. The water will then flow to the lower pool during daylight hours, generating 350,000 kw of electricity in the process. The project is possible due to development in recent years of pumping equipment which, in reverse, becomes electric generators.

Source of the power is thus still the coal used to produce the electricity required in the pumping operation. The same water is used over and over again, and serves merely as a storage medium for steam-generated electricity.



Schematic of Union Electric Co's Taum Sauk power plant. Upper pool, A, covers 50 acres 1000 ft above surrounding terrain. Water tunnel, B, is bored through granite to connect pool with 350,000-kw pump and generating station, C. Lower pool, D, is 370 acres on Taum Sauk Creek and Black River. E is impounding dam

The company's engineers turned to pumped storage because there is idle steam power capacity during the night hours in all power systems, when most industrial and commercial customers are largely shut down. This surplus power would be used at night for pumping the water to the upper reservoir.

At Taum Sauk it will require approximately three kwh of night-time surplus power to pump the water required to make two kwh in the daytime when it is needed. But despite this, the project will result in substantial economies for the Union Electric system. Chief among them is that utilizing idle night-time capacity will defer for some two years the starting of construction on a more costly new steam generating plant elsewhere on the system.

ALMASOL—
Key to New Vistas of Lubrication

By R. J. NEELY and EVERETTE O. WALDEN *

ALMASOL is a new ingredient which made its debut on the industrial market only last April, after two years of field-testing. It can perhaps be described best as an aluminum magnesium silicate complex, and it is from these components that the new ingredient derives its name. It has a laminar lattice-type structure which provides slippage or lubrication.

As engineering chemists in the fuels and petroleum section of Convair's Fort Worth division, we were among the first to test Almasol — and we were the first to use it in solid film applications. We found the answers to many previously unsolved problems, not only in our work at Convair but also in other phases of industry. Among these were the lubrication of: **a.** Elevon hinge pins in the B-58; **b.** hot gas by-pass actuators in the B-58; **c.** rotary-vane actuator shafts; and **d.** control rod bearings operating at higher temperatures.

As the result of our experiences with the new additive, we became more and more convinced that, with Almasol, answers could be provided to an ever-increasing number of industry's unsolved, or partially solved lubrication and coating problems.

Six Major Advantages

Field tests, research studies, and industrial usage have proved these six major advantages for the product: 1. Tremendous load-carrying strength; 2. low coefficient of friction; 3. chemical inertness; 4. a natural affinity for metals; 5. unusually long wear life; and 6. the ability to retain these important qualities, without change, up to temperatures of 1900 F.

This lubricant is thermally stable up to at least 2000 F, and does not convert to a crystalline structure at high temperatures, as do graphite and molybdenum disulfide. Further, it exhibits extreme pressure properties, thereby providing resistance to wear and reducing friction.

Being inert and water insoluble, Almasol does not introduce corrosion problems as do some other additives. It also provides anti-rust inhibition; and, by virtue of its chemical inertness, it will not in any way degradate the base metal.

These special formulations of the product have been developed: aircraft lubricant, bearing and instrument lubricant, enclosed-gear lubricant (SAE 90), enclosed-gear lubricant (SAE 140), bearing and chassis lubricant, and extreme-temperature lubricant.

A more or less standardized series of coatings, already in use and thoroughly tested, is classified into three groups, according to application.

Solid Film Lubricants

First, there's the 200 Series — for use in a temperature range of −300 F to +600 F, where permanent lubrication with exceptional long wear life (and low frictional properties) is required. These materials are highly resistant to hydrocarbon environmental conditions and will effectively resist corrosion. They withstand salt-spray and humidity tests.

Then, the 500 Series — for use in the intermediate high temperature range of −65 F to +900 F, where positive lubrication under high bearing-loads is required. Coefficients of friction for this series range from 0.03 to 0.08.

Also, the 800 Series — for use at extremely high temperatures, up to 1900 F. Coefficients of friction are slightly above 0.1 at room temperature, but usually decrease as operating temperatures are attained. Use of these materials prevents galling and seizing, inhibits fretting corrosion, and permits easy disassembly of parts after high-temperature operation.

A special series is for use in particular applications and consists of products containing Almasol powder in various base materials. The carriers are either selected solvents, greases, or hydrocarbon-type oils, whichever suits the intended application. Some areas where these products have been successful are in metal-working (as drawing compounds), as mold release agents, in die and forging operations, threading operations, and in spin forming and thread cutting. Also on oven chains and for kiln cars; as an additive to packings for pumps and valves; as thread compounds for quick release at high temperatures and for preventing galling and seizure; and on many other applications where heat, pressure, or inaccessibility are a problem.

This material can be used where corrosion (or protection from environmental conditions) is of primary concern. These materials are resistant to salt spray, humidity, and hydrocarbon environments. Excellent protection for exceptionally long periods has been obtained with these coating materials.

One coating is for use at higher temperatures, up to 900 F. There is also one for use at extremely high temperatures, up to 1500 F, under constant operating conditions and with intermittent operation at higher temperatures. (One particular member of this series has prevented the oxidation of molybdenum at 1200 F.)

These products and processes are particularly important in situations such as these: **a.** Where it is necessary to reduce the energy needed for motion, by reducing the friction between the parts; **b.** where a part requiring lubrication with long-wear characteristics must be sealed up or located at a point inaccessible to relubrication; **c.** where high temperatures and/or high pressures make conventional lubricants or protective coatings ineffective; **d.** where contamination problems make conventional lubricants or protective coatings impractical; and **e.** where it is necessary to eliminate galling and seizing between rubbing surfaces.

Users' Reports

Users have reported that Almasol reduces frictional heat, wear of parts, and costs of operation and lubrication, while tolerating heavier loads and extending service life and lubrication periods.

A lubricating grease with Almasol additive 185 has been proved to protect against salt water corrosion by a six-month service test. Cables and wire ropes were coated with it and immersed in sea water for the six-month period. At the end of the testing period, examination revealed that no rust or corrosion had occurred, and the coating was intact.

Thermal stability of Almasol has made its extreme temperature lubricant ideal for use around boilers.

Editor's note: For more information, write the Editor, or jot ALMASOL on the Inquiry Card included in this issue. THE END

* Vice-Presidents, The Almasol Corp

What Makes Flexible Couplings Flex

Here's what you should know about alignment of flexible couplings to keep your high-speed rotating equipment functioning smoothly

By H. N. HOFFMAN *

FLEXIBLE COUPLINGS, properly applied and serviced, have established a remarkable record of successful operation. Their manufacturers deserve considerable credit for the advancement which they have made in their product over the years, for flexible couplings have played a large part in making possible our present-day high-speed, smooth running equipment. If and when they do occur, flexible coupling troubles not originating from improper servicing are quite often found to stem from misapplication caused by lack of understanding on the user's part of the limitations of the product.

Word *flexible* in the name flexible coupling can be misleading, since it does not mean that this type coupling will give complete freedom of movement to coupled shafts with no transmitted force. Rather, it will give limited freedom of movement with low values of transmitted force. Failure to recognize these facts leaves the success of flexible coupling application to chance, often with disappointing results.

Manufacturers' catalogs on flexible couplings usually go into considerable detail concerning the rating, allowable speed, allowable misalignment, installation, and servicing information of their product. Rarely do they carry anything specific on amount of axial or lateral force which will be required to slip the coupling members while the coupling is carrying load. Reason for this is that the magnitude of these forces is as much a function of the application as the design of the coupling.

Since *gear tooth-type* flexible couplings are the type most commonly used, this article concentrates on this type in the figures and detail description. However, information is applicable to any type of flexible coupling in which relative movements of the connecting shafts require surfaces to slide within the coupling.

There are three major duties a flexible coupling is expected to do:

1. To transmit torque.
2. To provide flexibility between connected shafts to compensate for offset of shaft centerlines and/or angularity of shaft centerlines, Fig. 2.
3. To provide flexibility between connected shafts to compensate for axial movement of shafts.

In *tooth-type* flexible couplings, Fig. 1, the torque is transmitted through the coupling by gear teeth, each coupling having two sets of external and two sets of internal gear teeth, one set of these cut on members fastened to the shafts, the other to a floating member commonly referred to as a *distance piece*. Torque is transmitted through the coupling by mating gear teeth bearing against each other with an oil film between them.

To move the mating teeth of the coupling relative to each other while transmitting load requires a force to overcome the friction between gear teeth. This friction force is equal to the contact pressure between the gear teeth multiplied by the coefficient of friction between the tooth surfaces.

Lateral and Axial Forces

Total force required to overcome the resisting friction force within the coupling is made up of two components, one a force in a direction at right angles to the shaft centerlines, commonly referred to as the *lateral force*, and one in a direction in line with the shaft centerlines, commonly referred to as *axial force*. Coupling proportions determine the relative magnitude of these two force components.

Forces required to shift coupling parts to compensate for shaft misalignment, Fig. 3, will result in adding bending stresses in the shafts of the connected machines, increased loadings in the shaft bearings of the connected machines and, if appreciable, will very likely result in vibration of the equipment during operation. Existence of these forces are recognized by most flexible coupling users. They may be computed by the formula on the following page:

* Marine Development Eng'r, Small Steam Turbine Dept, General Electric Co

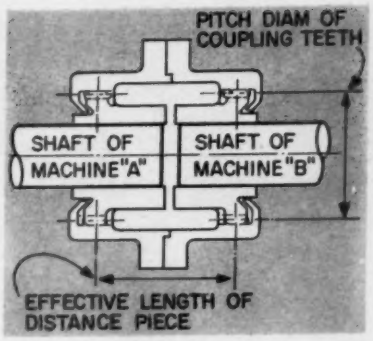


Fig. 1. A tooth-type flexible coupling, the type that is most commonly used

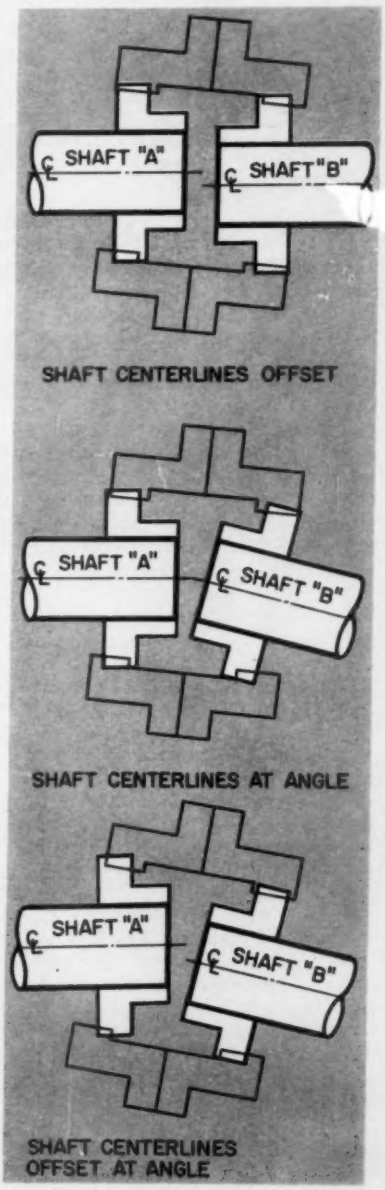


Fig. 2. Types of shaft misalignment that can cause flexible coupling failure

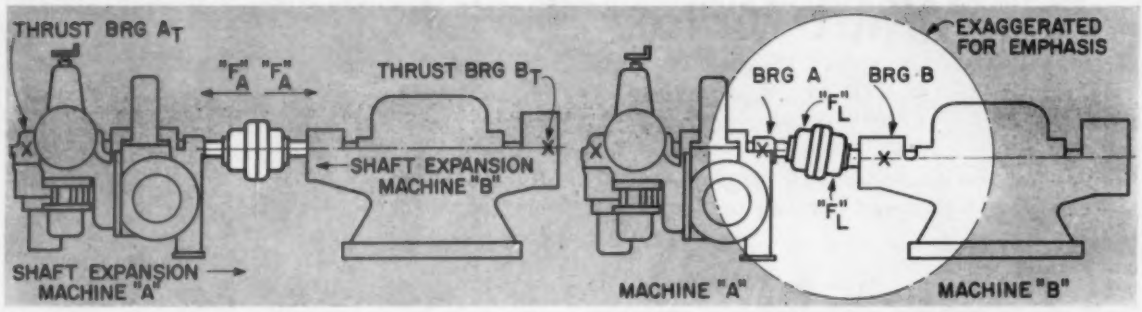


Fig. 3. Forces imposed on connected shaft as a result of misalignment impose bending stresses, add to the bearing load. Forces required to slide the coupling members axially to compensate for shaft expansion must be absorbed at A_t and B_t

$$F_L = \frac{63{,}000 \times HP \times f}{L \times RPM}$$

Where:

F_L = Force (lateral) to slip coupling.
f = Coefficient of friction.
HP = Horsepower being transmitted.
L = Length of coupling distance piece between centerlines of tooth faces.
RPM = Revolutions per minute.

Forces Absorbed

Forces required to shift coupling parts axially to compensate for axial shaft movements, such as shaft expansion due to shaft heating, must be absorbed by the thrust bearings, Fig. 3. The existence of these is sometimes overlooked or their magnitude underestimated by flexible coupling users. Failure to provide adequately for the axial thrust force which can be transmitted through a flexible coupling can result in thrust bearing failures of the connected machines.

As a typical example, assume the shafts of two machines having their own thrust bearings are coupled together with a flexible coupling. Machines are started and load applied. This results in a contact pressure force between the coupling teeth proportional to the load. The two shafts heat up, due to bearing friction and radiation from nearby hot machines or piping, and expand as a result. On long shafts this expansion can mean considerable change in length for relatively small temperature rises.

When the shafts have expanded to the point where the thrust collars of the two machines are forced against their thrust plates, the two thrust bearings fight each other until they have enough force to make the coupling slip axially. If one of the thrust bearings has less capacity than the other and is incapable of handling the thrust, it will fail in the process.

From this, it is to be noted that when two pieces of machinery on two shafts are coupled together with a flexible coupling, the fact that each has a thrust bearing with sufficient capacity to handle the thrust of its own shaft does not mean that this thrust is adequate when shafts are coupled through a flexible coupling.

Thrust bearings of flexibly coupled shafts or machines must have sufficient thrust-carrying margin above the needs of their own shaft requirements to handle the axial thrust which can be transmitted through the flexible coupling if thrust bearing failures are to be avoided.

In many cases where the thrust loads of each of the coupled machines are normally low and the transmitted torque high, the thrust bearing surface required to handle thrust which can be transmitted through the flexible coupling is considerably larger than that which is required for the basic machines.

A typical case is a motor-generator drive. Neither of these units require a very large thrust bearing in themselves; however, when coupled together with a flexible coupling, transmitted thrust values can be relatively high.

Axial thrust force, Fig. 3, which will be transmitted through a flexible coupling can be computed by the following formula:

$$F_A = \frac{126{,}000 \times HP \times f}{P.D. \times RPM}$$

Where:

F_A = Force to slip axially—lbs.
f = Coefficient of Friction.
P.D. = Pitch dia. of coupling teeth in inches.

Coefficient of friction between the contacting load-carrying tooth surfaces of the coupling while transmitting load is an unknown variable which depends upon many factors. Obvious and generally recognized ones are: 1. materials used, 2. condition of the tooth surfaces, and 3. lubrication.

Less obvious ones and those more difficult to recognize concern the application. Since the coefficient of starting friction is considerably greater than the coefficient of sliding friction, the force required to slip loaded coupling teeth in a drive having the supports, shaft stiffnesses, and alignment, such that no relative motion exists between the coupling teeth surfaces, will be considerably greater than in a similar drive where conditions are such that a slight degree of movement results between the teeth.

Force required to slip loaded coupling teeth axially in an application where the transmitted torque is very uniform will be higher than in an application with the same average torque but with higher and lower torque peaks since, in the latter case, axial slippage will occur when the low torque value occurs.

Coefficient of Friction

Coefficient of friction value to be used in determining the forces which can be transmitted through a flexible coupling for a given application can be determined best from what has proved successful in the same or similar applications. These values can vary widely for different applications. Experience indicates, and laboratory tests confirm, that in many flexible coupling applications, the coefficient of friction is under 0.1, but there are other cases where it has exceeded 0.3, and when inspected, the coupling tooth surfaces were found to be in good condition. Flexible coupling applications, where parts such as thrust bearings, shaft bearings, and housing and shafts have been designed to handle forces resulting from 0.2 coefficient of friction in the coupling, appear to have a good record of successful operation.

The intent of this article is only to show in applications where flexible couplings are used to connect the shafts of two pieces of machinery, an important fact to remember, and one which is frequently overlooked, is that some force is required to shift the parts of flexible couplings to compensate for shaft misalignment and axial movement of shafts, and that this force must be taken into account if operational difficulty is to be avoided. THE END

York's First Packaged Heat Pump

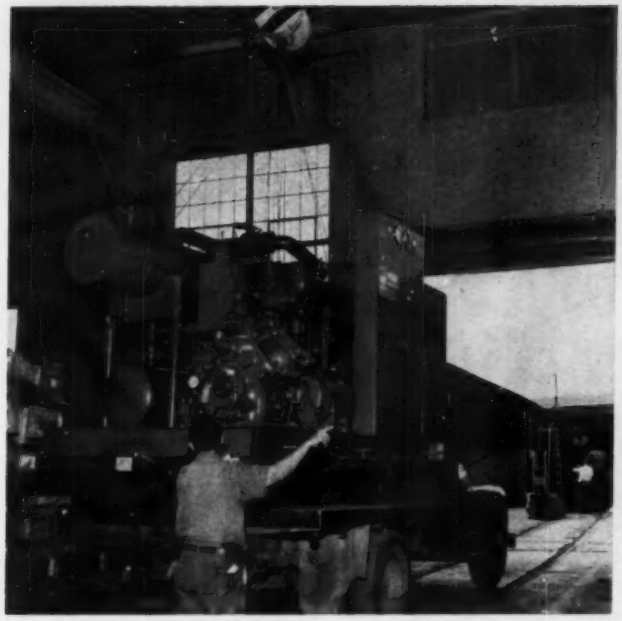


Fig. 1. Factory-assembled unit is loaded on truck for delivery to Morgan County Hospital in Madison, Ga. It has nominal cooling capacity of 54 tons, 230,000 Btu/hr heating at outside temp of 10 F

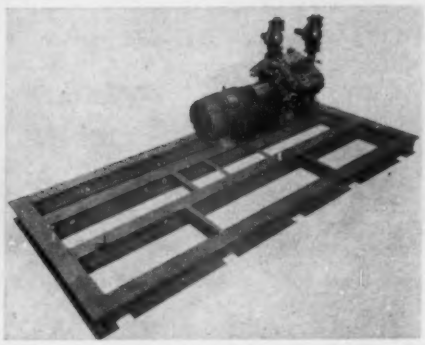


Fig. 2. First step in assembling ready-to-run system is to mount compressor on unit's base. This is start of air source pump, Model S-4

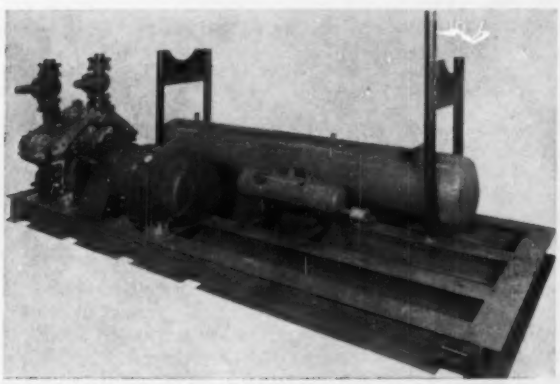


Fig. 3. Next, liquid receiver and oil receiver are installed. York makes these packaged units in 50–150-ton cooling sizes

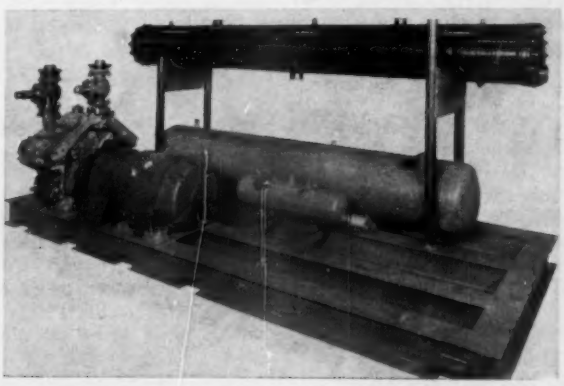


Fig. 4. Condenser is added to compressor, liquid receiver and oil receiver. Packaged units simplify installation process

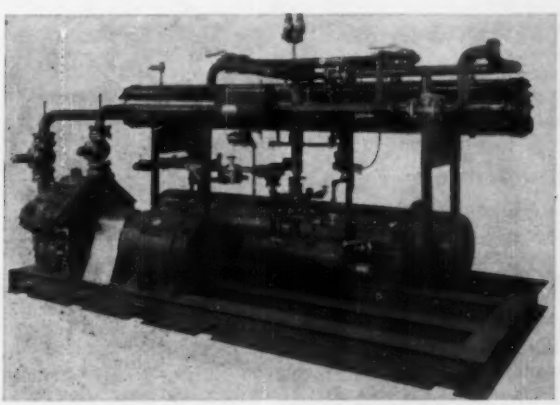


Fig. 5. Here piping has been added. This is how it looks from control box end of unit, minus control box and the insulation

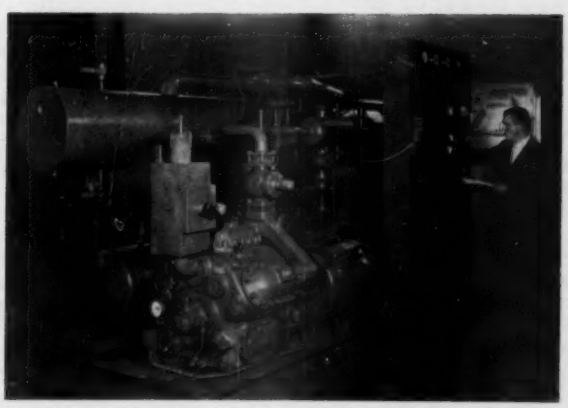


Fig. 6. Here control panel has been added and is getting inspection from J. R. Harnish, one of York's design engineers

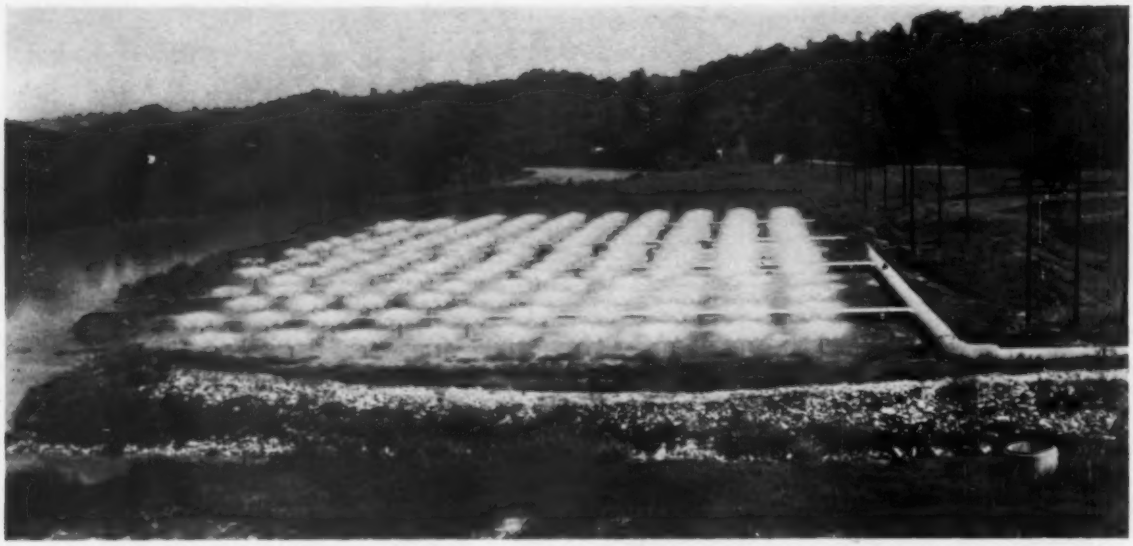


Fig. 1. Power plant building itself is located above the river. Flow to the pond is controlled by butterfly valves (see Fig. 2)

Dale Spray Pond Needs No Pumping Power

For cooling condenser circulating water at Dale Generating Station, Ford, Kentucky, spray pond cost least, required least maintenance, consumed no pumping power. This article details the why and how

By R. H. STANLEY*

ONE of the most interesting problems faced in the design of No. 3 Unit** of the Dale Generating Station for the East Kentucky Rural Electric Coöperative Corp at Ford, Kentucky, was that of providing sufficient circulating-water cooling. The circulating water for this plant comes from the Kentucky River, which varies widely in elevation through the year.

The normal pool elevation of this river at the plant site is 567.5 ft, and the design flood elevation at this point is 600 ft. Preliminary studies of water flows at the plant site indicated that during some portions of the year, the river flow would be less than the required circulating water flow. Thus, it was necessary to cool the circulating water as it was returned to the river so that it could be recirculated without an excessive increase in temperature and resultant loss in turbine efficiency.

Several solutions to this problem were considered. First, the surface cooling available from the river itself was studied. It was found that the amount of cooling expected by this means would not offset the amount of heat added to the circulating water in the plant condensers.

** Selection of Unit No. 3 for economy rather than efficiency was described in the February issue.

The next possibility which was considered was the use of a cooling tower. While this method would have worked satisfactorily, the cooling tower would have required auxiliary power to operate the fans. It also would have been necessary to locate the tower at an elevation above the design flood stage. Locating the cooling tower at this elevation would have required additional pumping power for the circulating water. This would have meant increasing the size of two existing pumps, as well as using larger pumps with the new unit. In addition, the cooling tower would be subjected to severe operating conditions because it would have only seasonal use. The remainder of the time it would stand dry. This fact would increase tower maintenance costs.

Why Not a Spray Pond?

The third alternative considered was the use of a spray pond to cool the water before it was returned to the river. The spray pond offered several advantages over the other methods considered. It required approximately half of the first cost of a cooling tower and would need less maintenance than the tower, due to the severe tower operating conditions. Also, no power would be required for spray pond operation. Therefore, the spray pond was selected as the most desirable and economical means of cooling the circulating water.

The general arrangement of the spray pond is shown in Fig. 2. The sealing weir shown in this figure is used to seal the circulating-water discharge header to provide a siphon through the condenser. In order to understand the operation of this sealing weir and the spray pond, it must be understood that the power plant building itself is located considerably above the river in order to guard against high flood stage.

Normal pool elevation is 567.5 ft, the plant basement elevation is 612 ft, and the top of the condenser is approximately at elevation 628.5 ft. Due to this large elevation difference, a siphon could not extend the entire distance between the river and the top of the condenser.

For this reason, a sealing weir was installed with a weir elevation of 601 ft to seal the end of the condenser discharge header and take advantage of the maximum siphon height practicable. Construction of this sealing weir is shown Fig. 3. From the sealing weir, the circulating water flows by

*Stanley Engineering Co

Fig. 3. Construction of sealing weir which provides siphon through the condenser. From weir, water flows by gravity to river or through pond

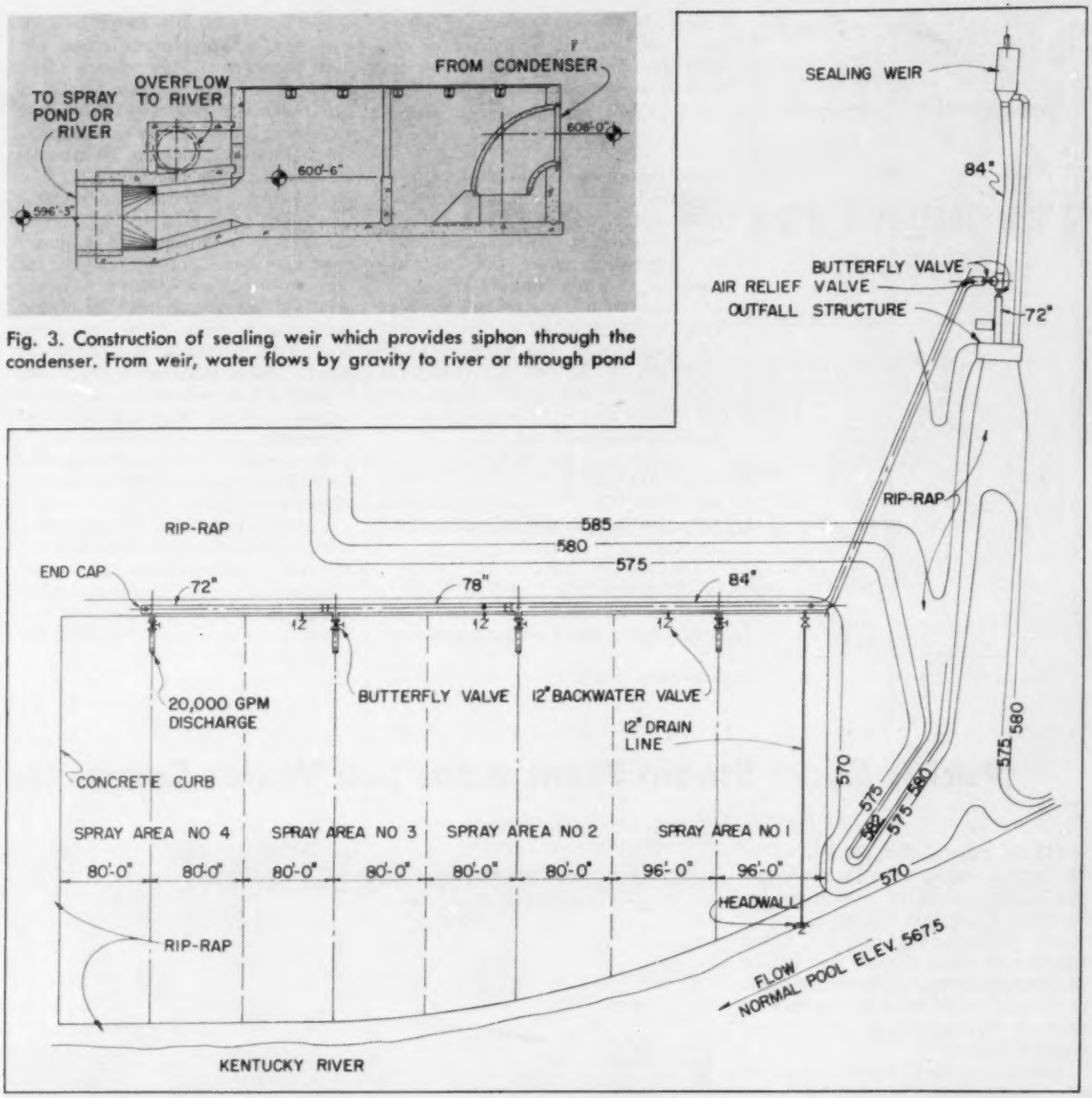


Fig. 2. Schematic of general arrangement of the spray pond. Weir seals end of condenser discharger header (see Fig. 3)

gravity either directly into the river or through the pond to the river.

Control of flow to the spray pond or to the river directly is accomplished by means of the motor-operated butterfly valves shown in Fig. 2. Therefore, due to the difference in elevation, a spray pond could be utilized with no extra pumping head.

As can be seen from Fig. 2, the spray pond was arranged in four areas, each handling 20,000 gpm. Size of each spray area was set on the basis of 0.4 gpm per sq ft. Available head at the inlet to each of the four areas ranged from 25.2 ft at area No. 1 to 23.4 ft at area No. 4.

One of the problems in the design of this spray pond was the fact that it would become submerged during high river levels. Main header to the spray pond was set at an elevation of 571.5 ft, which is only 4 ft above the normal pool elevation of the river. There were two major problems associated with allowing the spray pond to become submerged. First, there was a possibility of damage to the spray pond by floating debris, and second, there was a possibility of flotation of the large piping required by the installation.

In order to overcome these possible sources of difficulty, a rock embankment with a top elevation of 582 ft was constructed just upstream of the spray pond. This embankment was designed to intercept any debris which might damage the spray pond. Also, the spray pond was located on the inside of a bend in the river, and debris would tend to pass on the opposite side.

In order to prevent flotation of the pipe, air relief valves and backwater valves were installed as shown in Fig. 2 to allow the spray pond piping to fill with water as it became submerged. Since the spray pond operation was required only at low river flows, there was no operating disadvantage in allowing the pond to become flooded.

Since several manufacturers make different recommendations as to the nozzle sizing and spacing, the de-

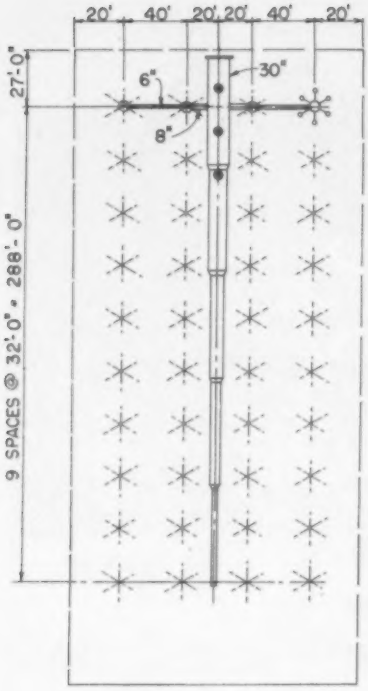


Fig. 4. Distribution system of spray pond, 240 nozzles in clusters of six, 83.5 gpm per nozzle. The nozzles are located at an elevation of 580 ft 9 in.

tailed design of the distribution system was left open in the specifications to allow competitive bidding. Bidders were required to guarantee satisfactory operation under the following conditions: rate of spray application, not more than 0.4 gpm per sq ft of area; temperature of circulating water to spray area, 108 F; range, 15 F; approach, 16 F; dry bulb temperature, 105 F; wet bulb temperature, 77 F; and finally, average wind velocity, 5 mph.

Construction was done by the Central Contracting Corporation with the Fluor Corp furnishing the distribution system design, piping, and nozzles.

Distribution system, as installed, is shown in Fig. 4. Due to the difference in dimensions of the various areas, the actual nozzle arrangement differs somewhat from area to area. However, a typical distribution system arrangement is shown. This arrangement provides for a total of 240 nozzles arranged in clusters of six, which allows a flow per nozzle of approximately 83.5 gpm. Nozzles are located at an elevation of 580 ft 9 in.

This spray pond has been in operation since 1956. Up to the present time, the conditions of minimum river flow, peak station output, and high ambient temperatures have not occurred simultaneously. However, performance tests have been conducted on individual sections of the pond. These tests show that performance for individual sections is somewhat better than that specified. Therefore, it is expected that the performance of the entire pond will be at least equal to that which was specified originally.

In this installation, the spray pond has provided a satisfactory and economical means of cooling the circulating water to allow full plant operation during periods of low river flows. THE END

Pacific Coast Steam Plant Adds Sea Water Converter

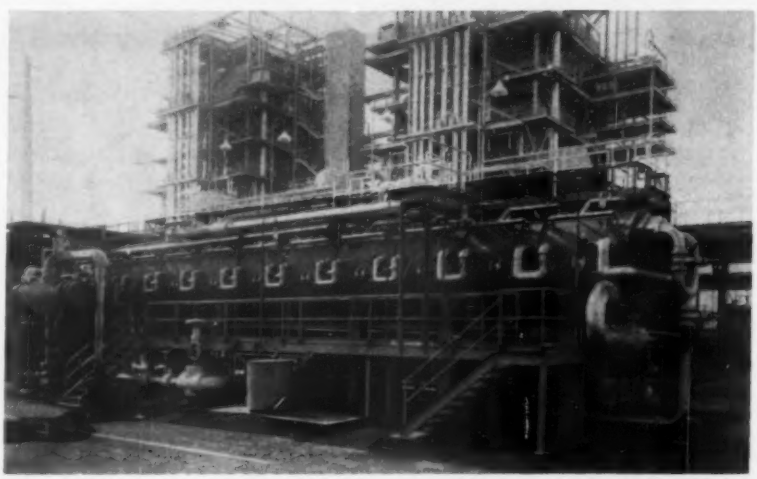
FIRST general purpose sea water conversion plant on the Pacific Coast has been placed in operation by Southern California Edison Co at its steam electric plant at Mandalay Beach near Oxnard, Cal. This is also the first sea water conversion plant of its kind to be used in conjunction with an existing steam electric generating station.

Edison's saline water converter uses steam which has nearly passed through the station's turbine and is extracted for use in the evaporator plant. As a result, it is relatively inexpensive heat.

Built by Cleaver-Brooks, the converter is a multi-stage flash evaporator which takes advantage of water's changing boiling point when pressure is varied. This type claims several advantages among which are: substantially scale-free operation; simplicity of operation; use of relatively low level heat sources; favorable initial cost.

The Edison converter has a capacity of 100,000 gal per day. Cost, including installation, is reported to have been in excess of $250,000. The entire unit used over eight miles of aluminum brass tubing and nearly 50 tons of steel sheet and plate.

The plant will be used experimentally in a search for a more economical method of extracting potable water from the sea by distillation. Experience and data derived from this pilot plant are expected to provide technical and cost information leading to the eventual construction of saline water plants with capacities of 5,000,000 to 10,000,000 gal a day of potable water. A three-year research program is planned.



New sea water converter uses steam from generating station's turbine to distill potable water. The 26-stage flash evaporator is said to be world's longest—70 ft

Since it is experimental in purpose, the plant is not expected to produce water at a cost competitive to present Southern California sources. The design incorporates an unusual scope for operating flexibility, making possible operation of the plant in a number of ways useful to experimentation.

Mar 29, 30, 31 . . .

22nd annual session of the American Power Conference opens at 10 a.m. on Tuesday, Mar 29, at the Hotel Sherman in Chicago, and continues for three days with a full program touching on all major aspects of the power industry. Over 90 papers will be presented

Three Busy Days for Power Engineers

APC's opening session this year will be addressed by W. Allen Wallis, special assistant to President Eisenhower and dean of the Graduate School of Business of the University of Chicago, and by John Conrad, president of the S & C Electric Co of Chicago. Walker Cisler, ASME's president, will speak at luncheon that same day on his recent experiences while visiting in Russia.

General interest session planned for Tues evening is built around the theme of advanced power concepts. Magnetohydrodynamic power will be discussed by Arthur Kantrowitz of Avco-Everett Research Laboratory. W. W. T. Crane of The Martin Co will speak on Isotopic Heat and Power, and Lt Col H. R. Schmidt of Washington, D. C., will bring the Conference up to date on the nuclear rocket program.

The AIEE luncheon will occur on Wed, Mar 30. Speaker will be Frank R. Barnett, director of research of The Richardson Foundation. The Western Society of Engineers will sponsor a Conference luncheon on the following day, Thurs, Mar 31.

All Engineers dinner, always a high point, is set for Wednesday evening, when Elmer F. Bennett, Under-Secretary of the Interior, will address the Conference.

The Conference is open to all persons interested in the generation, transmission, distribution or utilization of power. Sponsor is the Illinois Institute of Technology, with a number of universities and technical societies coöperating. Secretary of the Conference is Edwin R. Whitehead of IIT's Technology Center, Chicago 16.

Program coördinating committee this year has included: Adolph J. Ackerman, hydro power; Selden Adkins, water technology; R. A. Budenholzer, mechanical; Richard N. Bergstrom, representing ASME; F. L. Lawton, representing AIEE; D. A. Sullivan, general interest events.

For a quick résumé of special subjects to be discussed during the Conference, and when, see the accompanying table. THE END

Quick Guide to Special Subjects to be discussed—and when—at the American Power Conference on Tues, Wed, and Thurs Mar 29, 30, 31

(Individuals named are chairmen of the respective groups)

Central Station Plants and Auxiliaries: Thurs 9–12, M. P. Aillery, J. G. White Engineering Co.

Communications Protection and Control: Wed 9–10:30, J. A. Smith, General Electric Co.

Computers and Network Analyzers: Thurs 2–5, Prof J. J. Carey, University of Michigan.

Condensers: Thurs 2–5, Roy Sahlstrom, Faville LeVally.

Distribution and Subtransmission: Wed 9–10:30, E. L. Nicolson, General Electric Co.

Fuels: Wed 2–5 pm.

High Voltage Systems: Wed 2–5, F. L. Lawton, Aluminum Laboratories, Quebec.

Hydro Power: Rates, revenues and capital obligations, Wed 9–12, Adolph J. Ackerman; Financing plans, Wed 2–5 pm.

Industrial Plants: Power plant safety, Tues 3:30–5, Kenneth R. Hodges, Sears, Roebuck & Co; Thurs 9–12, F. G. Feeley, Jr, Olin Mathieson Chemical Corp; Thurs 2–5, Hugh H. Foreman, NAPE. Industrial Electrical, Wed 10:30–12, H. G. Frostick, U. S. Steel Corp.

Nuclear Power: Thurs 9–12, Raymond D. Maxson, Sargent & Lundy; Thurs 2–5 pm, Jerome D. Luntz, Editor of *Nucleonics*.

Power for Traction Vehicles: Tues 2–5, Prof D. J. Renwick, Michigan State University.

Power Generation for Peak Loads: Wed 9–12, Prof Francis Seyfarth, University of Illinois.

Space Heating: Tues 2–3:30, Prof Donald H. Madsen, State University of Iowa.

Steam Generators: Tues 2–5 pm, James D. Howard, Wisconsin Power and Light Co.

Switching and Switchgear: Wed 10:30–12, G. L. Welch, Westinghouse Electric Corp.

System Planning and Operation: Thurs 9–12, Prof M. Riaz, University of Minnesota.

Turbine Generators: Tues 2–5, Prof W. A. Lewis, Illinois Institute of Technology; Large Steam Turbines, Wed 2–5, H. L. Solberg, Purdue University.

Water: Conservation in Industry, Tues 2–5, Prof R. C. Porter, University of Michigan; Advances in Evaporation Techniques, Wed 9–12, Perry L. Blackshear, Jr, University of Minnesota; Ion Exchange, Wed 2–3:30; Conservation in Industry, Wed 3:30–5.

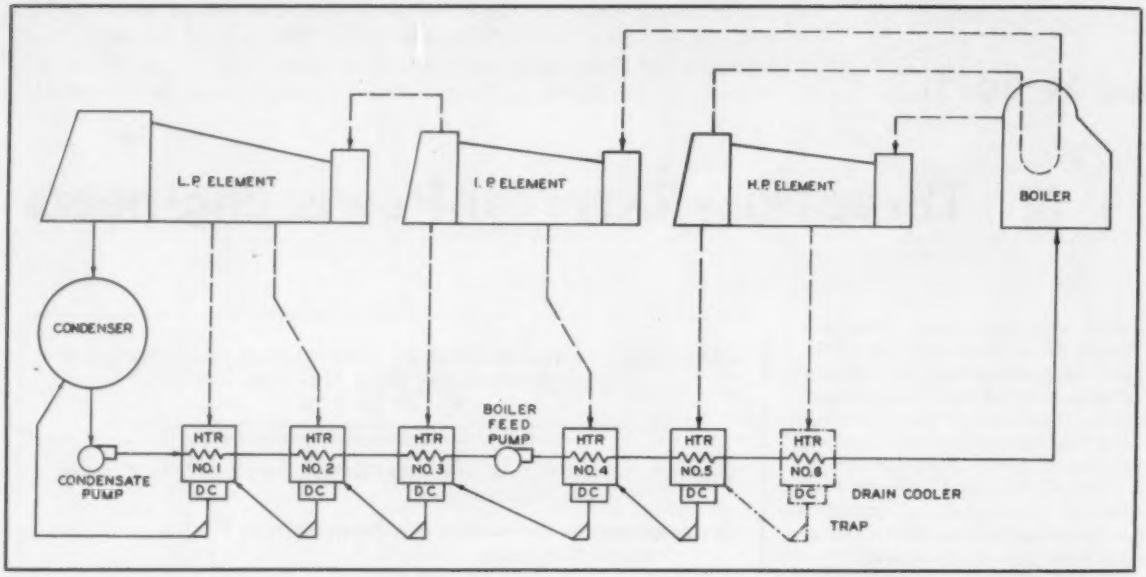


Fig. 1. Line diagram of steam flow in reheat regenerative cycle. Three-element illustration of turbine is diagrammatic only

Fundamentals of Steam Power Cycles

Here, in the first of two articles on thermodynamic principles of steam turbine operation, is one of the best, most easily understood reviews of steam cycle fundamentals we have seen. The author has a gift for simple, understandable definition of technical terms

By S. LEMEZIS *

PURPOSE OF any power plant is to convert heat energy from fossil fuels, or nuclear fission, into mechanical or electrical energy. This is accomplished by setting up a closed thermodynamic cycle of some working fluid, nearly always steam (H_2O), although ordinary air is the working medium in diesel and gas turbine plants. Steam turbines represent the *expansion* element in steam power cycles.

Any thermodynamic cycle is made to operate by putting work into the cycle fluid by pumping (or compression) at low energy levels and adding heat at relatively high energy levels. Energy is then extracted in the desired form at intermediate energy levels. Efficiency of cycles may be expressed in general terms, shown in box under **A.**

In plants intended primarily for electric power generation, this ratio is usually inverted to form the Plant Heat Rate, in box under **B.**

This is the "Power Plant Heat Rate," published in Federal Power Commission and Edison Electric Institute statistics, charges the plant with all losses between the maximum potential energy present in the fuel fired and the actual net electrical energy available for transmission to customers.

A

$$\text{Efficiency} = \frac{\text{Useful Energy Output in Desired Form (Mech. or Elect.)}}{\text{Heat Energy Input}}$$

B

$$\text{Heat Rate} = \frac{\text{Higher Heating Value of Fuel, Btu per lb times lb per hr Fuel Fired}}{\text{Net Power Plant Output, Kw}}$$

C

$$\text{Gross Turbine Heat Rate} = \frac{\text{Total heat supplied to steam turbine cycle in throttle steam, reheat steam, makeup water, boiler blowdown water or steam, and misc. sources}}{\text{Generator Output in kw}}$$

Since steam turbines and their associated feedwater heaters and piping represent about one-third of the total cost of a new power plant, the performance level of proposed turbines and details of the regenerative feed-heating cycle arrangement always receive careful attention from the plant designers. Turbine and feed-heating cycle performance are invariably expressed and guaranteed as a *Turbine Heat Rate*, defined in box under **C.**

This is numerically equal to the plant heat rate if all components except the turbine and feedwater heaters are assumed to operate at 100 per cent efficiency, or with zero power requirements. Heat rate equations are completely arbitrary, and there is considerable variation in the practice followed by various consultants, users, and manufacturers when expressing the performance of a given turbine and feed-heating cycle in this manner. Comparisons between performance of several alternate turbine-feed heater cycles will be valid only if the same heat rate equation is used for all the propositions.

Because the entire useful output from any power plant is obtained by converting heat into mechanical energy of rotation in the turbine (expansion) element, it follows that the turbine itself and its operating cycle must be designed for the highest conversion rate attainable within the plant's economic limitations.

Historically, steam turbine cycles have fallen into three broad classes,

*Design Eng'r, Medium Turbine Eng'r'g, Steam Div, Westinghouse Electric Corp

each of which has been dominant during some era, and all of which are used today to an extent depending upon the economics of a particular installation.

It should be noted that all steam plants, whose primary purpose is the generation of electric power, operate on a condensing cycle; that is, the working steam is expanded from throttle pressure and temperature down to an exhaust pressure which is only ½ to 1½ psi above absolute zero. These low exhaust pressures are obtained by condensing the exhaust steam to water at temperatures near or slightly above room temperature. Condensate is all returned to the boiler to begin another cycle.

It is very seldom that a chemical process or heating system will require low-pressure and -temperature steam in the quantities which a turbine would exhaust when expanding steam to pressures near atmospheric. In the few instances where this might be true, a non-condensing turbine might prove to be the most economical power generator.

Three fundamental arrangements of a condensing steam cycle are:

Straight Condensing. These were employed almost exclusively before 1920 and are still used in small installations, usually industrial plants under 10,000 kw, today. Throttle steam may be saturated or superheated, but every pound of it is expanded all the way down to exhaust pressure and is converted to water in the condenser. This water, at hotwell temperature, is then fed to the boiler.

Regenerative Feedwater Heating. This is employed almost universally today. Since some ⅔ of the total heat energy present in each pound of steam at throttle conditions still remains when it has been expanded to condenser pressure, and since each pound of steam leaving the turbine exhaust must be condensed in order to maintain condenser shell pressure at its low absolute value, it follows that some ⅔ of the heat put into the steam by a boiler working with a straight condensing turbine is necessarily lost in the condenser circulating water.

Regenerative feedwater heating was introduced in the early 1920's to prevent loss of at least a portion of this *latent heat* from the cycle. Condensate from the condenser hotwell is passed through a series of feedwater heaters before being reintroduced to the boiler. Some 25 to 30 per cent of the throttle steam flow is extracted from between turbine stages at various points during the expansion process, and this extracted steam is allowed to condense in the feed heaters, thus giving up its latent heat to the feedwater instead of rejecting it in the condenser.

For each pound of throttle steam, then, only 0.65 to 0.80 lb actually has to give up its latent heat to the condenser circulating water; remainder of the latent heat is *plowed back* into the boiler feedwater. Fitting even a few heaters to a straight condensing cycle in this way increases the cycle efficiency substantially.

Reheat. This is employed almost exclusively today in units rated 60,000 kw and larger, always in conjunction with regenerative feedwater heating. Reheat involves sending the steam back to the boiler after it has been expanded to about 25 per cent of throttle pressure in a high-pressure turbine and there adding sufficient heat to raise its temperature close to that at the throttle. This lower-pressure, high-temperature steam is then expanded to exhaust pressure in IP and LP turbines. Gain in cycle efficiency is achieved at the cost of complication and extra expense for turbine, boiler and piping. For at least the larger units, this extra cost is nearly always justified.

Figure 1 is a line diagram showing the flow path of the working medium in a reheat regenerative cycle of moderate rating. By mentally removing the reheater and/or the feedwater heaters, the same diagram can represent a non-reheat regenerative and a straight condensing cycle, respectively. Representation of the turbine as three separate elements is diagrammatic only. Physical size of the complete turbine (rating, steam pressure and temperature) will determine if all these elements should be built separately, in multiple, or joined into one or two casings.

Figure 2 is a temperature-entropy diagram for water vapor. The abscissa is entropy, a mathematical factor which is the measure of the unavailable energy in a thermodynamic system. It is used as a coördinate, primarily because of its dimension — Btu per degree F per lb of fluid — so that areas on the diagram represent energy, and the relative amounts of energy involved in processes can be compared visually.

Second and concluding article in this series will appear in* POWER ENGINEERING *for April.

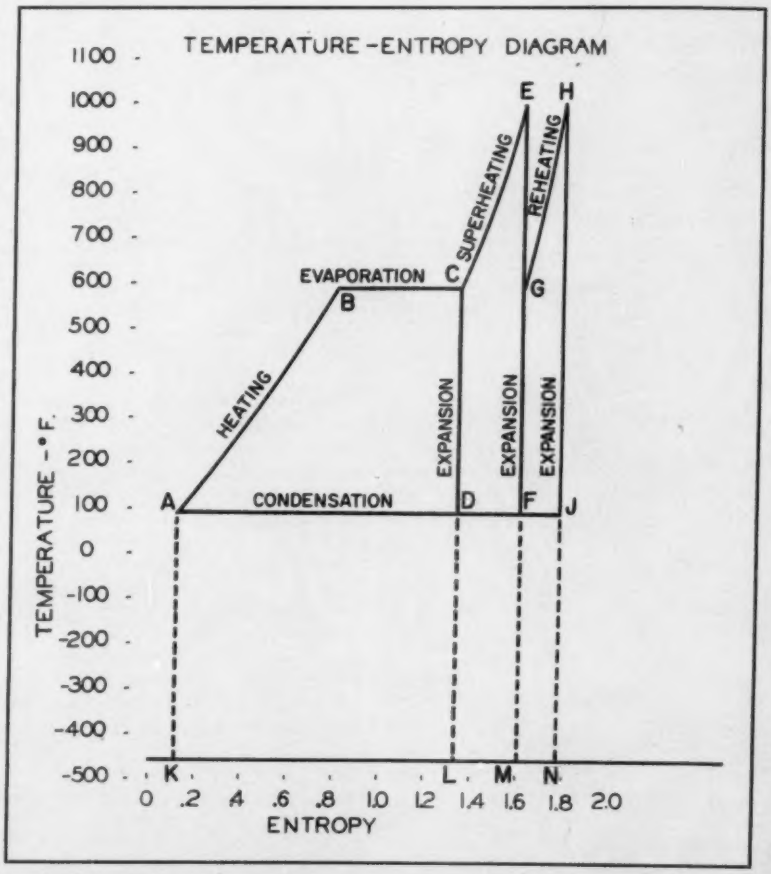
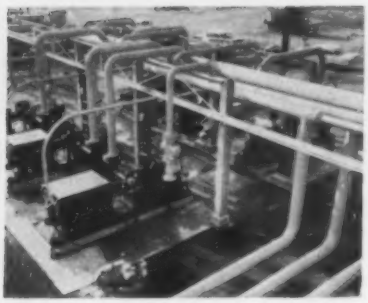


Fig. 2. Temperature-entropy diagram for water vapor showing cycle energy areas



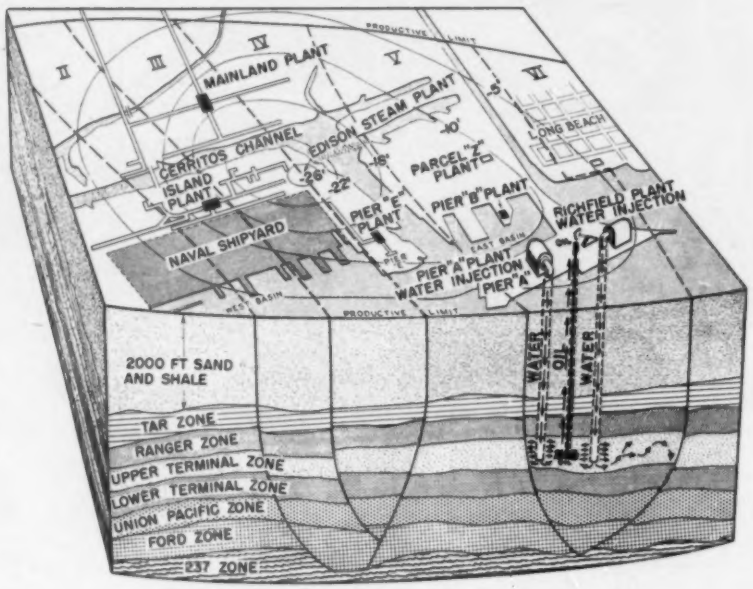


Fig. 1. The Island water injection plant supplies 157,000 barrels per day of sea water for repressurizing underground regions below subsidence area. Fig. 2 (r) schematizes the water injection principle. Shown is the Wilmington Oil Field divided by fault blocks indicated by Roman numerals. Water injected drives the oil ahead of it toward producing wells, and simultaneously fills the voids left by oil in the reservoir rock

Long Beach Uses Water Injection to Stop Land From Sinking

LONG BEACH, Cal, is meeting its land subsidence problem by a $30,000,000 underground repressurizing program using water injection.

As reported in POWER ENGINEERING of November, 1957, page 85, the land has for many years been sinking under the city. Lowest area is Terminal Island, where there is a Naval shipyard and base, and where the Southern California Edison Co has a steam plant. This area is also part of the Wilmington Oil Field, second largest in the nation.

Last October, batteries of pumps driven by motors totaling nearly 10,000 hp began forcing filtered sea water into injection wells drilled into the area most critically affected by subsidence, and Long Beach looks forward confidently to the solution of this problem. Coöperating in the water injection program are the City of Long Beach and the oil producers.

Sketch shows the Wilmington Oil Field divided by fault blocks. A 20-square-mile area has subsided from 2 to 26 ft. The maximum sinkage of 26 ft occurs at the center (Edison Steam Plant). Sinkage of 3 to 5 feet has been recorded in downtown Long Beach (upper right, Fig. 2).

Water injection is being used to repressure the oil field. The principle of water injection is demonstrated at Pier A (right center). Oxygen-free salt water is pumped under great pressure down into or adjacent to the oil-bearing rock formations in the various fault blocks (designated by Roman numerals across the top of the drawing) from which oil is produced. The injected water drives the oil ahead of it toward the wells through which it is produced, and fills the voids in the reservoir rock previously occupied by the oil. In this way more oil is produced and pressures in the reservoir rock are increased simultaneously.

Due to its numerous fault blocks, the Wilmington Oil Field actually is several oil fields in one. Thus a mammoth water injection program is required, which it is planned will eventually reach a combined daily water injection schedule of 1,000,000 barrels (44,000,000 gallons).

The two new water injection plants (Mainland, upper left, Fig. 2, and Island, left) which were opened last fall bring the present daily water plant injection capacity to 874,000 barrels. The plants were designed by the engineering firm of M. A. Nishkian & Co, and financed at a cost of about $2,500,000 by the City of Long Beach. Some 120 injection wells are being provided in addition, either by drilling or conversion.

Prolonged pumping of corrosive salt water will put heavy demands for durability on the pumps installed. Submersible motor-driven pumps were selected for the job. Each pump utilizes an efficient turbine pump assembly and is suspended from the well head, hanging plumb with motor and pump submerged in the well.

The first 12 units are specially-designed Wintroath pumps that feature non-corrosive construction throughout. The 75-hp General Electric motors have heavy duty rotors and stators fully enclosed and sealed in type-316 stainless steel cases. Assembled above the motors are the stainless steel vertical turbine units. Flanged lengths of column pipe that conduct the water to the surface of the well are plastic coated steel. Bearings are Vanco plastic, specially designed for maximum service life when the lubricant is salt water.

As a final protective measure against corrosion a 42-in.-diameter standpipe surrounds the top of each concrete well casing. This standpipe extends 5 feet above the surface. The pump discharge head is sealed at the top of the standpipe flanged joint, and the entire interior is pressurized with nitrogen to exclude outside atmosphere. From the source wells, the salt water is delivered to a pressure station that forces the water back underground at 1500 lb pressure.

THE END

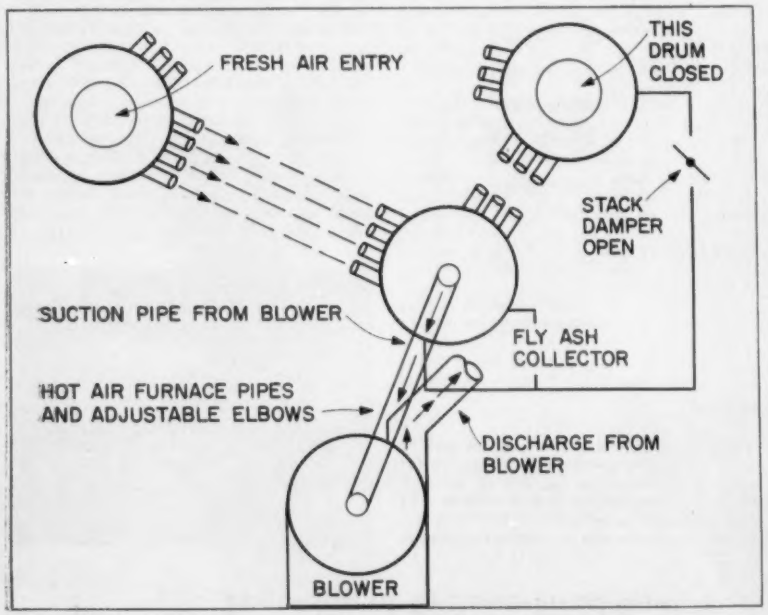
cut along this line

Power Engineering handbook

Simple Way to Get Fresh Air to Tube Cleaner

By H. W. STOLLENWERK

SKETCH shows a system we use to keep the air fresh and clean for the tube-cleaning operator at Kearney & Trecker Corp in West Allis, Wis. We use a suction fan with the suction pipe of the fan inserted through a piece of plywood which is clamped over the man-hole of the mud drum. Blow-down pipe is covered so as not to accumulate excess scale. Discharge pipe of the fan is inserted into the fly-ash collector clean-out door. Stack damper is opened enough to create a small draft. Man-hole plate is in closed position. With this set-up, fresh air is drawn into the drum in which the operator is working.



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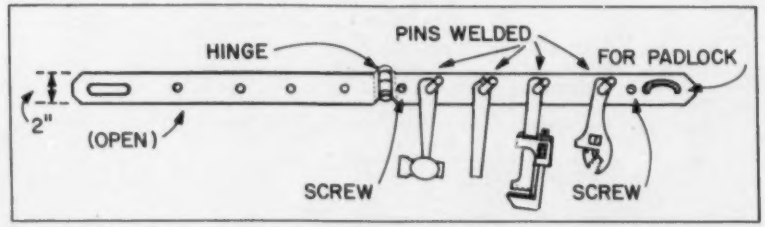


⅛-in. strip of iron is attached to wall. Tools not in use are hung on the pins and locked into the crib

How to Keep Track of Tools

By JAMES M. CURRAN

THE TOOLS in our machine shop (at St. Raymond Paper in Desbiens, Quebec) were continually being lost or mislaid, until we thought of the following way of remedying the situation.

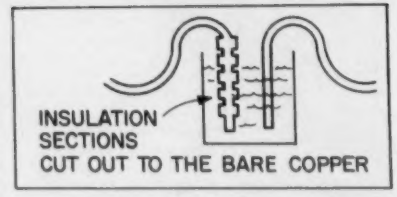
A strip of iron, about ⅛-in. thick and hinged at the middle, was screwed into the wall. Pins are welded on the strip, equally spaced, and the tools are perforated so that they can be hung up.

The strip can be any length, depending on the number of items to be handled, and the width should be about two inches.

After a tool has been taken out of this tool crib, the remaining items are locked up. The man in charge can see at a glance if the rack is full or empty, and any tools missing are immediately searched for in the plant.

Fixing That Transformer Leak

By H. MULLER



WHEN THE OIL from a bank of transformers persisted in leaking out from the bottom elbows of the drip loops on the primary conductors feeding them, investigation revealed that the high potential cables had insulation of candlewick.

Capillary action drew the oil up out of the transformer tanks, along the cable, and dropped off at the lowest point of the drip loops.

Remedy was to drain the tanks partially, after the juice was shut off, then disconnect the feeders, and ring them. The ringing consisted of cutting out two or three sections of the insulation on each conductor where it was immersed in the oil. That way, the oil stopped its creeping the moment it hit the bared sections of the cables, which interrupted its further travel.

Another bit of experience from our shop may be helpful to others:

In our work with light-gage steel tanks, we have to install or remove handles, brackets, and other accessories. But heat from the acetylene torch will frequently warp the walls of the tanks.

We prevent this casualty by filling the tanks with water, which permits using the torch but prevents warping.

Speaking of Cyclone-Fired Boilers . . .

Based on sessions of the operators' training program conducted at Lakeside Station in Springfield, Illinois, by station superintendent F. H. Wilcoxon. This is the third of these training articles which began in the Handbook of September, 1959.

THE CHIEF and his crew are meeting with Mr. B, manufacturer's expert on the cyclone furnace and boiler. The plant is considering the possible purchase of such a unit.

Tom: Mr. B, is it necessary to operate soot blowers on cyclone-fired boilers?

Mr. B: The unit is so designed that there are no large particles at all, no heavy materials to give a scrubbing action in the convection pass section or collector parts of the boiler. But you do get a very fine deposit on the tubes, which can seriously cut down the heat transfer; and actually, in the hotter zones this can build up and sinter, to produce a slag deposit. So you do need soot blowers.

Use of the soot blowers will not be any more frequent than would be expected on a pulverized coal-fired unit. If the soot blowers aren't used, you will find a gradual reduction in the heat absorption and a pick-up in the gas temperatures. Super-heater temperature is the best indication of when to operate the soot blowers.

Chief: We have been concerned about lighting up a cyclone burner. It would seem that the burner would be filled with raw coal when lighting-off before the temperature had increased enough to melt the slag.

Mr. B: Actually, the lighting up of a cyclone burner is no more complicated than with a PC burner. Conditions are just as quick as with a PC burner. You have to fire with oil until you get air temperature up, and the coal fineness should be set up a little finer. Where you bring in another burner on a boiler that is already hot, only four or five minutes are required to operate the oil torch to stabilize that burner.

Chief: How about bringing the boiler up from a cold start where you must fire very slowly. Would you fire intermittently?

Mr. B: We do not like to run on intermittent firing in a cyclone, or with any type of firing. We have found that on most of our cyclone-fired boilers we can set the coal feeder at minimum feed and fire continuously to bring the unit up until it is on the line. In your case, we are talking about a 7-ft cyclone on a 230,000-lb-per-hr boiler; so you will probably fire with oil for two or three hours, to get some temperature inside. Then start your coal feeder at minimum speed and fire until the unit is up to pressure and on the line.

Dick: On a unit system, where you are trying to bring the turbine on with the boiler, do you fire with oil until you get the turbine on the line, and then come on in with the coal feeder?

Mr. B: What we are mostly concerned about is the temperature of the primary air. Once you have that high enough, you can fire with oil or coal, as you choose. As a service engineer I would start rolling a 1200-psi turbine at about 600 psi and would have a load on the turbine about 45 min after it started coming up to speed. When you are ready to hit the turbine with the electric load, the boiler would be up to pressure and the superheater would be cleared.

Dick: If you got ahead with the boiler, would it be all right to shut the boiler off and let it sit there?

Mr. B: That, incidentally, is a hot bank procedure. Prior to starting your turbine you would either be coming up from a week-end shutdown with a bank boiler, or the boiler would have been fired long enough to be up to possibly half-pressure.

Joe: In a cyclone-fired boiler, is the furnace under about 15-in. pressure?

Mr. B: No. It won't get that high. It is only about 8 in.

Joe: Do you have air pressure on your peep holes and inspection openings?

Mr. B: If you're not used to pressure operation it may sound complicated. On one boiler job in Wisconsin, we supplied ID fans. The only time the ID fans were used was during the boiling-out process. Since then, they have liked pressure firing so well that they have only used the ID fans once or twice in three years of operation.

Lon: What type of FD fan is used on a cyclone-fired boiler?

Mr. B: First to explain pressure firing: You blow the air through the burners, and you blow the combustion products through the boiler and through the stack without keeping the furnace under suction. The furnace is actually under pressure — about 8 in. — and the closer you get to the stack, the closer you approach 0-in. pressure.

The FD fan we use actually creates a pressure of about 40 in. in a duct. Its only control for that pressure is adjustable inlet vanes. There is no fluid drive or change of speed of the fan at all. Certainly a directly-connected fan to the motor, with inlet vanes to control the pressure, is all that is required, as well as the air to the cyclone. There are secondary air dampers that proportion the amount of air to the fuel fed to each furnace.

Advantages of cyclone pressure-fired units are that you get rid of the ID fans, which handle dirty, hot gases (the FD fans handling clean, cool air). This reduces maintenance, reduces initial costs, and possibly most important, there is zero air leakage into the setting. In the cyclone furnace you have 13 per cent excess air, and when you get to the stack you still have 13 per cent excess air.

In a suction job, you start at the furnace with 13 per cent excess air, and by the time you get to the stack you will have as much as 30–35 per cent excess air. This air must be heated and wasted out of the stack, at tremendous cost in reduction of efficiency. The difference can be as much as 1 per cent in efficiency between a pressure job and a suction job.

Tom: What do you do at the soot blower opening to prevent leakage?

Mr. B: We provide seals and aspirating rings to blow a little air through the openings to offset the pressure. These doors are interlocked so that they can't be opened until the aspirating air is turned on.

Tom: What air do you use for the aspirating air?

Mr. B: This can either be station air or air from the discharge of the FD fan. It is known as sealing air. We prefer to use station air since pressure is higher and the pipes can be smaller.

Chief: Do you normally use one FD fan for a multiple cyclone-fired boiler, or do you use two FD fans?

Mr. B: In a boiler of this size — 230,000 lb per hr — only one FD fan would be needed; but if two fans were used, they would be tied to the same duct.

Dick: How do you arrange the combustion controls to proportion air and fuel at the cyclone burner?

Mr. B: Air to each burner is measured with the venturi, which is an indication of air flow, and this is tied back to feeder speed. These are calibrated at unit start-up time to give us proper coal-air ratio and proper combustion.

When your master calls for more steam, it increases the feeder speed and air to maintain constant pressure. The inlet air vanes at the FD fan are operated from a duct pressure control. The secondary air velocity is maintained by the secondary air damper at the inlet to the cyclone burner.

A cyclone requires about 20-in. differential pressure across it to make it function properly. If the pressure is too low, you will lose the cyclone action in the burner. It will start sloughing off and coal-collecting. You would be operating about 36-in. maximum pressure at full load on the cyclone, dropping down to about 30-in. minimum at low rating.

Chief: Is it necessary to install a mechanical dust collector with a cyclone-fired boiler?

Mr. B: On some very large units we have installed both mechanical and electrostatic dust collectors. But on the unit we are considering here, we would not use any dust collector, since the ash that goes to the stack is very fine and a mechanical-type collector would be ineffective. In a cyclone furnace, only 10

POWER ENGINEERING HANDBOOK

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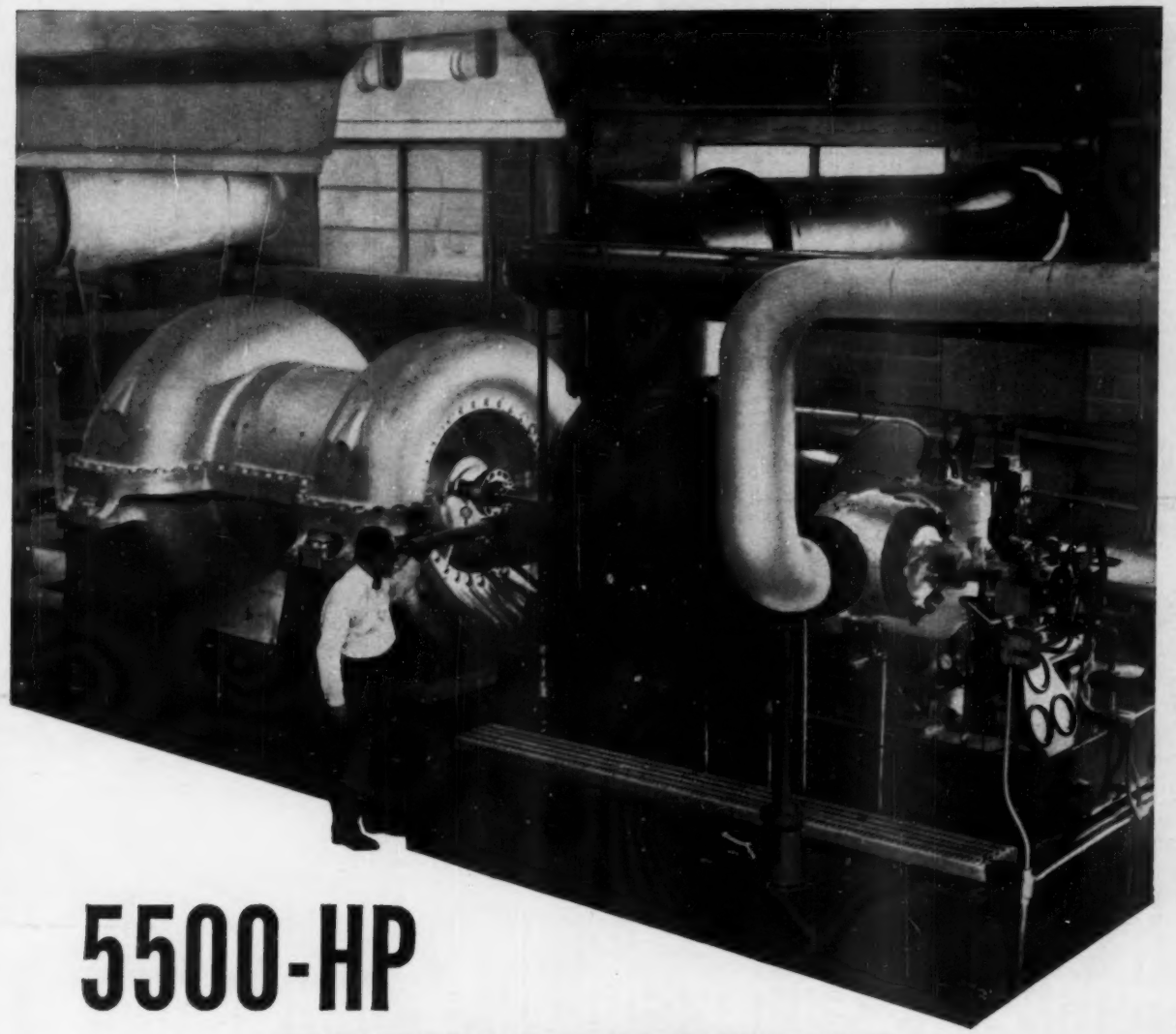

5500-HP TERRY TURBINE

plays an important role in compressor testing at Joy

Joy Manufacturing Company puts Terry high-speed turbine reliability to good use in its development facility at Buffalo, New York. This 5500-hp multistage turbine is used for testing centrifugal and axial-flow compressors. It provides speeds up to 9,000 rpm.

The long, trouble-free life of Terry high-speed turbines stems from two sources: (1) more than 50 years of successful experience in making turbine drives *exclusively*, (2) a willingness to build *something extra* into each machine to assure its reliability.

There's a reliable Terry turbine for you in sizes up to 6000 hp. In special cases higher outputs can be supplied.

For more information about Terry multistage turbines, ask for a copy of bulletin S-146.

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per cent of the ash goes through the boiler, as compared with the 80 per cent you are getting with your present boilers.

Joe: You mentioned coal size for a cyclone burner. Is it more desirable to keep it fine?

Mr. B: Actually, the size should be 85 to 90 per cent through ¼ in. with uniform grading down to about 10 per cent through 200 mesh. If you get it too fine it will carry on into the furnace, and if you get it too coarse you won't get complete combustion in the burner. We like to have at least 10 per cent through 200 mesh to maintain proper ignition; we will take more, but we don't want to take any less.

Jack: Is the coal blown into the cyclone or does it flow in by gravity?

Mr. B: We have blown the coal in, but we prefer to feed it in by gravity with an apron-type feeder. The coal is fed in at the nose or vortex of the burner with the primary air, which gives it initial spin, and then it travels to the center of the burner where the secondary air is blown in tangentially at high velocity. This whirls the coal around inside the burner to complete combustion.

The entire burner is lined with 1 7/16-in. tubes on 1½-in. centers. The first foot or two of the boiler tubes are left bare to prevent any slag formation interfering with the coal stream entering the burner. Beyond this point toward the furnace the pin studs are welded to the tubes to hold the refractory coating to the tubes.

When the boiler is shut down, the molten slag lines this portion, which is maintained during operation and protects the tubes and studs. The studs are about 5/16 in. in diameter and ½ to ¾ in. long. These studs will burn back or become shorter due to abrasion, oxidation, etc, and will have to be replaced, but you will have five years or so of operation before this is necessary.

At the vortex, where the coal comes in, there will be abrasion due to the coal and air velocity, so we install wear blocks. These are placed around the periphery of the vortex or the primary burner. The first four or five blocks which are subjected to the most wear are coated with very high wearing resistant material. Normally the life of the blocks is in the neighborhood of 150,000 tons of coal.

Dick: How do you replace pin studs?

Mr. B: These can be replaced during a shut-down. The old pins are chiseled off and smoothed off with a hand grinder, and the new studs are welded on with a Nelson stud gun. This is a resistance-type welding gun which merely requires loading and pulling the trigger.

Dick: Do the tubes in the cyclone burner run lengthwise?

Mr. B: No, the tubes run radially around the circumference of the burner.

Joe: Do these wear blocks have to stand a lot of heat in the vortex?

Mr. B: No. We actually introduce enough air with the coal to keep the blocks cool.

Lon: What size are these cyclone burners?

Mr. B: They are built in sizes from 5 ft in diameter up to 10 ft in diameter, depending on the boiler capacity.

Lon: What size is the cyclone boiler compared to a pulverized coal-fired boiler?

Mr. B: A 330,000-lb-per-hr boiler would be 18 ft wide from side wall to side wall. The furnace volume in a pulverized-coal-fired boiler has to be a lot larger to provide for mixing and burning the coal, while in a cyclone-fired boiler all of the burning is done inside the 7-ft diameter burner. This permits us to reduce the size of the furnace considerably.

Dick: Where is the forced-draft fan placed?

Mr. B: Actually, the most convenient location would be on the operating floor or lower, preferably at the same elevation as the cyclone burners.

Chief: You mentioned that the forced draft fan you use acts as a compressor.

Mr. B: It is a fan, but in one sense of the word it acts as a compressor because it discharges at 40 to 50 in. of static pressure. This raises the temperature from 80 F ambient at the inlet to 120 F at the discharge; so you actually pick up about 40 deg in the fan due to compression, which helps prevent air heater corrosion.

Tom: How does wet coal affect the operation of a cyclone burner? Does it reduce the rating of the boiler?

Mr. B: Everyone who uses a tube mill and other pulverized-coal equipment has trouble getting the wet coal out of the mill. This is not true of a cyclone boiler. In a cyclone it doesn't make any difference. Once the coal has entered the cyclone burner, the moisture doesn't affect it.

fold along this line—outside edges toward you

How to Make an Emergency Square Punch

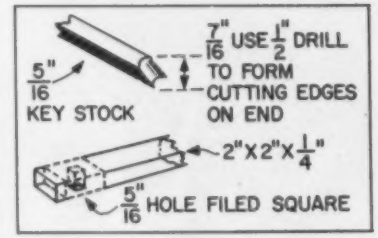
By LEWIS C. VAN HUBEN*

RECENTLY I had immediate need of a square punch to expedite some repair work in my plant. None was available, and there wasn't time to shop around. I got out of the difficulty by making one, as shown in the sketch. The tool did a very acceptable job, cutting clean square holes of exactly the right size on hardened aluminum alloy, copper, brass, aluminum and lead up to just under ¼-in., and on galvanized iron and soft steel up to ⅛-in. Here's how to make the punch:

Select a piece of key stock equal to the size of hole desired. Using a drill slightly larger than the diagonal cross-section of the key stock, drill out the end of the stock leaving four points at the corners and a curved cutting edge on the sides.

For the die block any available piece of flat metal will do. I used a short section of 2 by 2 by ¼-in. angle iron. Using a drill equal to the side of the key stock, drill a hole and file out the corners with a square file. Do not overfile. The key stock punch should just slip through without binding.

For a guide take a hard wood block and drill a hole using the same drill as for the die block. Broach square with the key stock punch.



Key stock is size of hole desired. Dotted lines show position of hardwood guide held by C-clamps

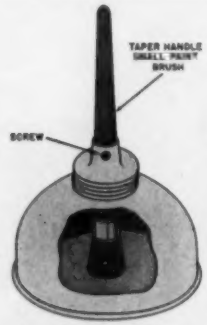
To use, clamp the guide to one side of the angle iron leaving a space that will clear the metal to be punched. Line up the punch and the die block with the punch in the guide before clamping.

Two or three sharp hammer blows will punch a clean square hole in any soft metal up to 3/16-in. thick.

For thicker or harder metals the punch can be tempered using any of the "quickie" hardening compounds now on the market.

To resharpen the punch, simply chuck it in the drill and drill out a little more stock.

*Chief Engineer, Rockland State Hospital, Orangeburg, N. Y.



Air-tight small brush container made from oil can

It doesn't have to be big or fancy

Any idea, however simple, is welcome in the Handbook—provided it's practical and helps to do a job better somewhere in the power field.

For this kind of on-the-job material, we pay up to $35.

So jot down the facts about some problem situation that has been solved in your plant, and send them to us. In the form of a letter, if you like. Include rough sketches and/or snapshots. We'll do the rest.

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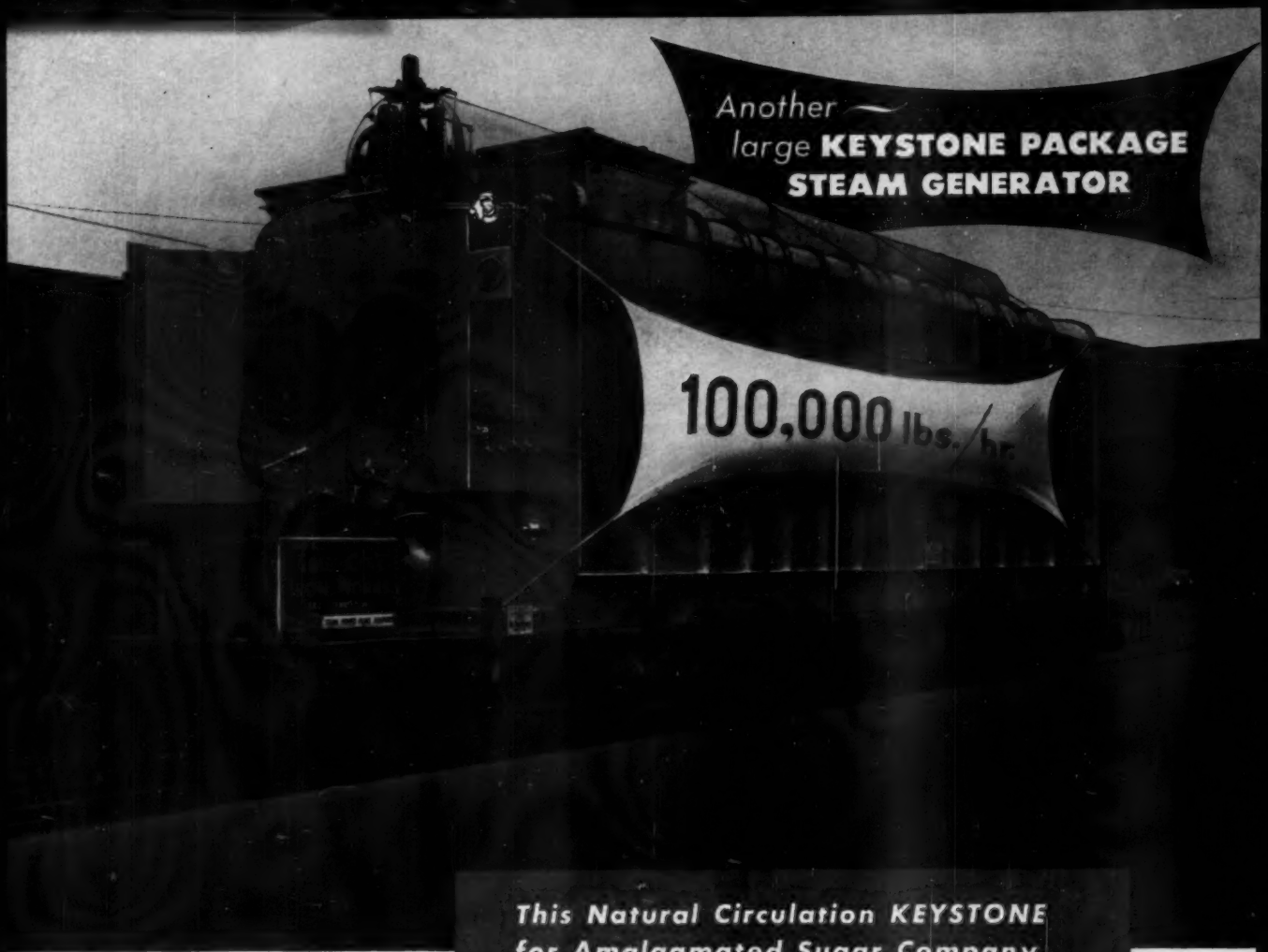

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The Keystone design was developed in the 1940's for engineers who demand top performance in water tube package steam generators. Unique features of this design make the Keystone the wise choice of engineers who specify and buy package boilers.

- **Symmetrical Design** — Easy to unload — easy to move.
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- **Tangent Outside Tubes** — Plus steel jacketed insulation for minimum heat loss.
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- **Undivided Responsibility** — Firing equipment designed and manufactured by Erie City Iron Works.
- **Minimum of Maintenance** — No baffles — headers — key cap or handhole plates.

Keystones use only tubes for heating surface. No fins, studs or other extended surfaces of questionable value are used. The Keystone packs more real heating surface in the smallest space resulting in lower exit temperatures and highest efficiencies. ***Get the details in Bulletin SB-5902-C***

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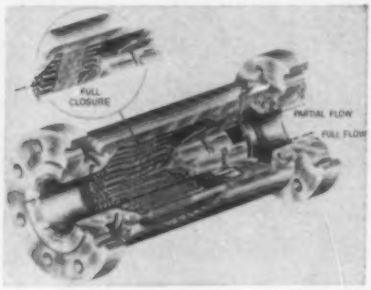
EQUIPMENT NEWS

Reader Service Cards on pages 105–106 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

1—PLUG VALVE silently throttles the fluid flow

Aeration, cavitation, surging, vibration and the resultant noise, associated with rapid flow of fluids, are claimed virtually eliminated by the Silent Valve. Flexible in size and scope, this valve can be supplied for installation in systems with line sizes from 1 in. to many feet in diameter, handling a variety of fluids.



Heart of the valve is a cylindrical plug of elastomer having a large number of axially aligned holes which serve as flow passages. This plug is contained in a tubular housing between two perforated plates, one of which is either hydraulically or mechanically actuated to compress the elastic insert. As the plug is compressed, flow passages are reduced in diameter thereby throttling the flow. At full compression, these channels are closed and complete shutoff attained. Use of a large number of small-diameter flow passages permits energy associated with large pressure drops to be dissipated smoothly by fluid friction within the tiny channels, it is explained, and dynamic underpressures are virtually eliminated from the throttling. Aerojet-General Corp.

2—REGULATOR controls temperature, pressure

This unit is designed to control temperature and pressure with only one regulator in the main line. It anticipates temperature change through pressure sensing mechanism. Sliding gate seats are self-cleaning and self-lapping in operation. Designed for heating and cooling applications, unit is available in ¼- to 2 in. sizes with screwed ends. Standard body materials are ductile iron (Model 1168) or bronze (Model 1268). It is suitable for pressures to 250 psi and temperatures to 500 F, designed to control temperatures from 35 to 450 F with 10 ranges and pressures of 2 to 200 psi with two ranges. Bulletin SRBc 4–60 gives more details. OPW-Jordan Corp.

3—INDUCTION MOTORS for the high-speed applications

These squirrel cage induction motors are offered in 100-5000 hp, 514-3600 rpm, frames 584–11320. A one-piece, wrap-around steel plate cover running the full length of the frame, extends well below the center-line of the motor on each side to provide natural drip-proof protection and to increase rigidity of the frame structure. The double end ventilation system serves to provide maximum cooling. Motors are available with silicone rubber as well as Class A, B and H insulations. Due to incorporation of company's oil lubricated bearing and a split-type bearing bracket, bearing replacement, when necessary, can be accomplished without uncoupling the motor or disconnecting leads. Ideal Electric and Mfg. Co.

4—RADIO SYSTEM is light in weight, small in size

This personal radio system is designed to provide two-way wireless communications for industrial applications demanding small size, minimum weight and dependability. It is a limited range system, utilizing a transistorized transmitter-receiver unit weighing less than 1 lb, including batteries. Units come in five standard models. The one shown has a noise-cancelling headset with built-on antenna and noise-cancelling microphone; unit and batteries are in a compact belt-pack.

Features include a transistorized industrial-type printed circuit with crystal

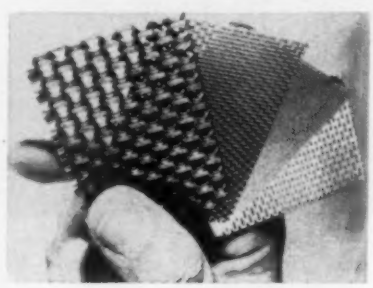
controlled transmitter and superheterodyne receiver, providing 750 milliwatts of usable radio power. Units are available for use in 27 megacycles or 42 megacycle operations; the former requires no license. Since the units are built to be part of the wearing apparel of the user, and not hand held, they afford convenience of use. They may be used in conjunction with a "base station" to extend range, or act as a "clearing house" for messages, and are reported especially useful where high noise or poor visibility conditions prevent direct local or visual contact. Prices start around $200, without batteries. Seiscor Div., Seismograph Service Corp.

5—OXYGEN ANALYZER—no chemicals, no moving parts

The Magnox Analyzer, a unit for continuous measurement of O_2 in gases, has automatic temperature compensation, it is announced, yet uses no chemicals and has no moving parts. With an accuracy of ± 1 to 2 per cent of full scale and a stability of ± 1 per cent of full scale over more than a year, according to company, analyzer provides accurate data for efficient fuel burning, permits economical ceramic firing and closer control of kiln atmospheres, measures purity of oxygen and nitrogen. Bulletin 1059 gives details. Milton Roy Co.

6—PIERCED METAL SHEET increases screen life, throughput

Conidure is claimed to last up to three times longer than perforated metal for screening, recovering, or dewatering coal, aggregate, chemical solutions and similar solids-bearing liquids passing through gravity or centrifugal separators. Throughput efficiencies are also said to

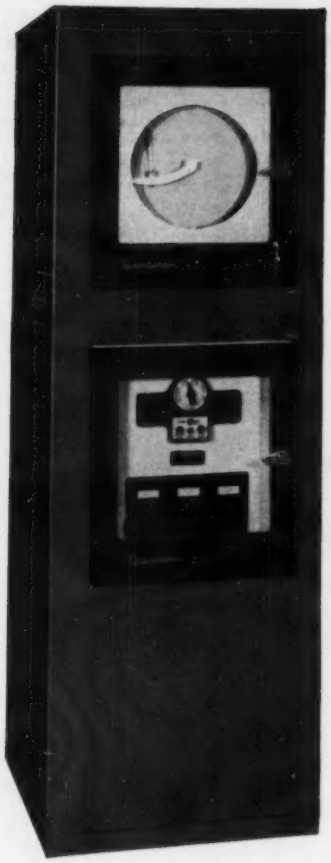


be substantially higher. Conidure is made by a process in which trapezoidal holes are pierced in sheets of carbon or stainless steel, copper, brass or aluminum. Sheet thickness can be up to seven times hole diameters, which range from 0.004 to 0.099 in.

The working side of Conidure comes in several degrees of smoothness from unrolled to rolled flat with electrolytic polish. This side which has the smaller end of the tapered holes has humps that act in shovel-like fashion to guide material to the openings. Conidure is available in sheets up to 31 in. wide or formed into sheared shapes, cones, segments, others. National-Standard Co.

7—SOLVENT ADDITIVE makes tough cleaning jobs easier

To speed removal of unusually stubborn compounded soils, Oakite Acalaid is added in the range of 5 to 10 per cent by volume to company's acidic or alkaline solutions to increase their power. It is economical because you use it only where needed to boost standard solutions, says manufacturer, and it may eliminate need of more concentrated cleaners. It may be used in tanks at temperatures between 140 and 160 F; and in closed systems at temperatures between 180 and 200 F. Field tests are



AUTOMATIC COLORIMETRIC ANALYSIS

in the parts per billion range

Now you can perform delicate colorimetric analyses for silica and other parts per billion trace contaminants right on the plant floor . . . without supervision. Quantichem® Analyzers continuously, automatically perform every step of a wet laboratory analysis with unprecedented accuracy and dependability. The field-proved Quantichem analyzer is so stable and foolproof that it actually provides *greater accuracy and repeatability than tedious manual techniques.*

The first step in each Quantichem analysis is standardization, in which *sample* and *zero* cells are flushed with sample while the instrument zeroes itself. Although no Quantichem analyzer has yet exhibited so much as 1% drift in 24 hours, standardization is a valuable safety feature. It ensures results *independent of photoelectric tube characteristics, line voltage variation, sample turbidity, or dirt on the cell windows.* If a dirty cell window or failing light source prevents zeroing, an automatic signal is actuated.

After standardization, the pneumatic programming drum which controls the instrument actuates the unique Minus Delta P® diaphragm metering pumps. Precise amounts of as many as four reagents (within ±0.25%) are delivered to the cells in the desired sequence. The analysis reaction is permitted to go to completion, *eliminating any chance of temperature or timing errors.* The dual beam optical system which illuminates both cells ensures uniform light intensity and *eliminates possible errors due to light source inequality.*

Any difference in light intensity transmitted by the two cells unbalances the measuring bridge circuit, actuating the Quantichem recorder and associated instrumentation. Then a new analysis cycle begins with flushing of the cells and standardization.

Quantichem analyzers are now available for dissolved silica, dissolved oxygen, hydrazine, total hardness, residual chlorine, dissolved iron, and other trace determinations. Most analyses are accurate to within ±3% of full scale, and sensitive to ±1% of full scale. Designed and built to take tough industrial usage, Quantichem analyzers provide long service life with minimum maintenance. All wetted parts are constructed of corrosion-proof materials.

Complete information on them is provided in Bulletin 1156-1, available on request. Write to Milton Roy Company, 1300 E. Mermaid Lane, Philadelphia 18, Pa.

milton Roy

CHEMICAL INSTRUMENTATION SYSTEMS

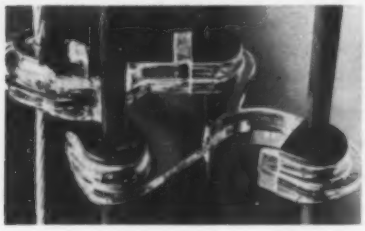
Controlled Volume Pumps • Quantichem Analyzers
Chemical Feed Systems • pH Instruments

For more data circle 540 on Post Card

reported to show it effective in cleaning heat exchangers and processing columns. It is neutral in pH, assuming that of the solution to which it is added. It is described as having a pleasant, aromatic odor, and as containing no phenols, so that disposal presents no special problem. Oakite Products, Inc.

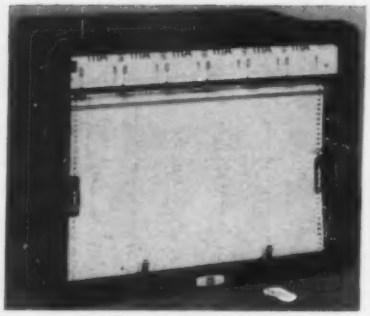
8—AERIAL CABLE SYSTEM has aluminum messenger

This spacer type aerial cable system features a simply designed spacer, a high-strength aluminum messenger and insulated phase conductors. Because all elements are designed to be used together, an entire system, installed, is reported to cost considerably less than pre-assembled aerial cable and only slightly more than standard open wire.



The spacer, for systems operating at 5 to 15 kv, is a compact, high strength, one-piece Plexiglas unit with Neoprene grommets. Slotted to slip around the cable, these grommets snap into the spacer's guide paths, but are held securely once in position. Only one cable need be handled at a time and installation of each spacer takes but a few minutes, it is noted; and with no movable or removable parts, the spacer has a high degree of mechanical reliability.

Cables are held 6 in. apart. The $\frac{3}{8}$-in. aluminum messenger, composed of seven strands, has two strands of EC grade conductor and five of Alumoweld. Other type of messengers are also available. Phase conductors are hard drawn EC grade aluminum with minimum conductivity of 62 per cent IACS. Polyethylene and butyl rubber insulations are available, Neoprene jacketed. Kaiser Aluminum & Chemical Sales, Inc.



10—STRIP CHART RECORDER six-channel, rectilinear type

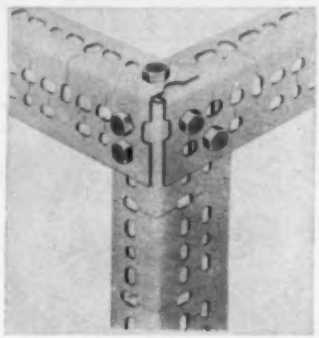
This instrument provides six independent non-overlapping and continuous records within a compact unit only 12¾ in. wide, 9$\frac{13}{16}$ in. high and 8¾ in. deep. It is suited for recording volts, milliamperes, or other variables available as outputs from electrical or electronic systems. Major features announced include sensitivity to 1 ma full scale; 1.0 sec response time; interchangeable pens for ink or inkless recording. Two, three, four and five channel models are available, and channels can be mixed. Chart speeds are available from ½ in. per hour to 24 in. per minute. Princeton Div., Curtiss-Wright Corp.

11—INDUSTRIAL FANS have broad range of applications

For exhausting gases, corrosive fumes and for handling of granular or fibrous materials, this line of fans includes three blade shapes, a wide range of wheel and inlet sizes and five arrangements. The fans come in AMCA standard wheel sizes from 19½ to 64¾ in., with 11 inlet sizes from 11 to 37 in. Air and gas fumes handling wheels have backwardly-inclined blades. For pneumatic conveyor systems there is a granular materials handling wheel with straight blades. To permit easy movement of stringy or fibrous materials, straight wheel without side plate is available. Fan housings are of reinforced steel. The Trane Co.

12—STEEL FRAMING for supporting electrical equipment

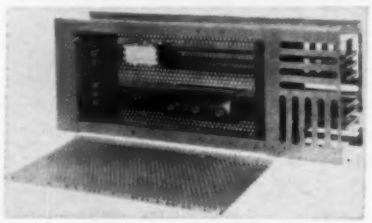
Called the Right Angle Method, this line of slotted angle is intended for framing control systems, suspending conduit, pipe, ducts, trays and cables, and for structural support of electrical equipment. It is made of steel with a brightened, electro-galvanized finish. This corrosion-resistant finish permits installations with regard for additional painting, but provides a good bonding surface for paint, if desired. It is produced in three sizes (the medium is shown), to satisfy weight, strength and dimensional requirements of the job. Each has measure and cut marks spaced at ¾-in. intervals with a special mark at 3-in. intervals. Hole-and-slot patterns



are repeated on 3-in. centers with markings for cutting. This framing is designed for interchangeable application in all sizes within the same structure and with other makes of slotted angles. A portable cutting instrument with centering pin for exact cutting mark alignment is available and adapted to all three sizes. Steel City Electric Co.

13—BUSWAY for electric utility excitation

Designed especially for electric utility excitation systems, company says this busway can be economically used instead of conduit and cable for a variety



of exciter-to-generator systems. Four types of construction — indoor or outdoor ventilated, and indoor or outdoor totally enclosed — can be supplied with either copper or aluminum conductors in ratings to 4000 amp at 500 v d-c. Westinghouse Electric Corp.

14—WELDING CABLE CONNECTOR resists overheating

This welding cable connector won't overheat or arc, it is announced, and joins securely with a twist of the wrist. An eccentric-locking or wedging action is designed to provide efficient electrical contact — preventing overheating. According to company, normal wear in-

9—PROXIMITY LIMIT SWITCH offers operating advantages

The Gemco Switch is designed to combine characteristics of both conventional mechanical limit switch and proximity type of sensing system. Like the former, it has a set of contacts that operate in response to the actuating means provided. Like proximity switch systems, it operates without physical contact with its actuating means. It consists of an armature carrying a set of silver contacts disposed within the field of enclosed permanent magnets. The normally closed contacts are held closed by the force of that magnetic field. When a foreign ferrous part is brought into the sensing area of that field (normally set at ⅜ in.), the armature snaps its contacts to the other position to close its normally open contacts. It remains in that position until the foreign part is removed from that sensing area.

Association of magnets, armature and contacts is such that this switch is claimed unaffected by anything other than very strong external magnetic fields. Manufacturer says it is generally suitable for use close to or upon resistance welders and will not false trip. Containing just one moving part, the switch is only 4¼ in. long, hermetically sealed in a brass housing. It is claimed impervious to coolants, abrasive dust, temperatures from −50 to 250 F. It operates without transistors, tubes, coils, relays or amplifiers, requires no power output. It is smaller than conventional systems, and costs less. General Equipment and Mfg. Co., Inc.

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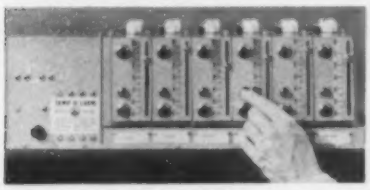
For more data circle 541 on Post Card

creases contact area, extending connector life. Molded Neoprene covers are used to prevent short circuits and outside arcing, and resist oil and grease damage. Connector has soft copper sleeves to permit cable attachment by lead soldering or crimping. Model 120 is designed for use with 1/0 and 2/0 cables; Model 340 with 3/0 and 4/0 cables. Ampco Metal, Inc.

15—ALARM DEVICE tells when equipment overheats

Temp-O-Larm is designed to trigger an alarm when temperatures in production equipment reach an overheat condition. The equipment comprises a thermostat pre-set to actuate at any desired temperature. When temperature in a unit reaches this point, it sends a signal to an

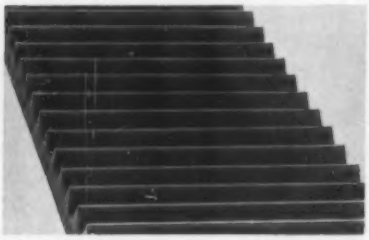


annunciator which causes audible and/or visible alarms to sound locally, at a remote location, by telephone line.

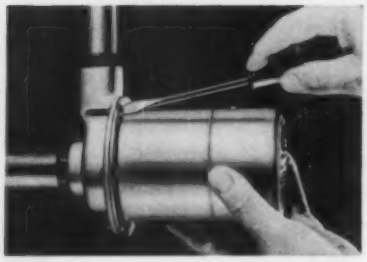
Each annunciator has an alarm time delay for setting from zero to 6 hr, to eliminate possibility of false alarms during expected and normal overheat temperatures. One of two annunciator drive units available monitors one to six production units; the other drive unit monitors seven to 12. It is pointed out that this equipment could also be used to warn of low temperatures or sound an alarm at any temperature for which a closed circuit thermostat is available. It operates on 115-v, 60 cycle a-c, with exposed connections of low voltage. Walter Kidde & Co., Inc.

16—CONVEYOR BELT carries objects up inclines

Dur-A-Lift Belt is designed for carrying objects up an incline as steep as 45 deg, and some objects to 50 deg incline. It will convey smooth, rough or slippery objects without sliding, company says. Top cover consists of parallel, transverse, inverted V-ridges of wear-resistant Dulon, making it more resistant to abrasion, gouging, tearing and oxidation. Deep V-ridges are said to be self-cleaning and assure maximum grip action. Balanced belt construction equalizes ply stress so that each ply pulls its



full share of load. Belt is available in three- or four-ply 28-oz duck, and can be had in other constructions with molded edges, bottom cover, and other fabrics to 48 in. wide. Boston Woven Hose & Rubber Co.

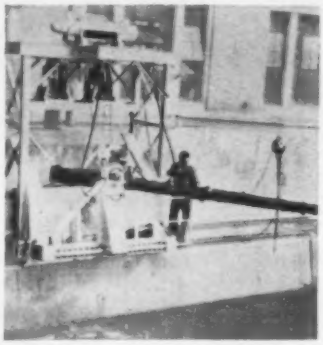


17—CANNED PUMP is compact, low cost unit

Dynapump Model 420D weighs less than seven pounds, it is announced, yet is capable of pumping over 800 gph, and is designed to produce heads up to 12 ft. Constructed of corrosion resistant material, the leak-proof pump is said to offer all of the advantages of canned pumps. Since rotor, shaft and impeller form a single assembly enclosed or "canned" in a stainless steel cylinder, there is no stuffing box or mechanical seal to permit leakage, company says. Pumped fluid itself circulates in rotor chamber and acts as bearing lubricant and motor coolant. Suitable for pressures to 150 psi, temperatures to 220 F, for operation on 115 or 220 v, single phase, 50 or 60 cycles. Automatic overload cutout protection is provided. Dynapump Div., Fostoria Corp.

18—HYDRAULIC RACK RAKE clears trash from water inlets

For dams, hydroelectric plants and other installations where trash removal from water inlet racks is a problem, this hydraulically operated rake is designed to



remove trash from the very bottom of the racks, keeping them clear their full length. It is adaptable to present installations, or furnished complete with hoist carriage, moving apron or trash hopper. Standard equipment includes power operation for carriage traverse and rake hoisting. Bulletin 94 describes the rake. The Portland Co.

Described on these pages are new and improved products. Use Reader Service Cards on pages 105–106 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

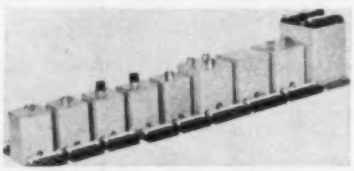
19—WELDING GUN is manual carbon dioxide type

This manual Aircomatic (company's gas-shielded metal-arc process) welding gun is announced for use on mild steel using carbon dioxide as a shielding gas. The air-cooled gun, designated Model AH60-B, has a continuous duty rating of 600 amp d-c when using "buried arc" CO_2 techniques. It is designed to accommodate hard welding wires ranging from 0.035 to 3/32 in. fed from conventional Airco wire feeders. Gun is equipped with a lever type trigger for simple operation and has a goose-neck

nozzle assembly for ease of welding in hard-to-reach areas. It is claimed particularly effective where rugged applications and high duty cycles are likely to be encountered. Air Reduction Sales Co., Div., Air Reduction Co., Inc.

20—REGULATOR MODULES are versatile, compact in size

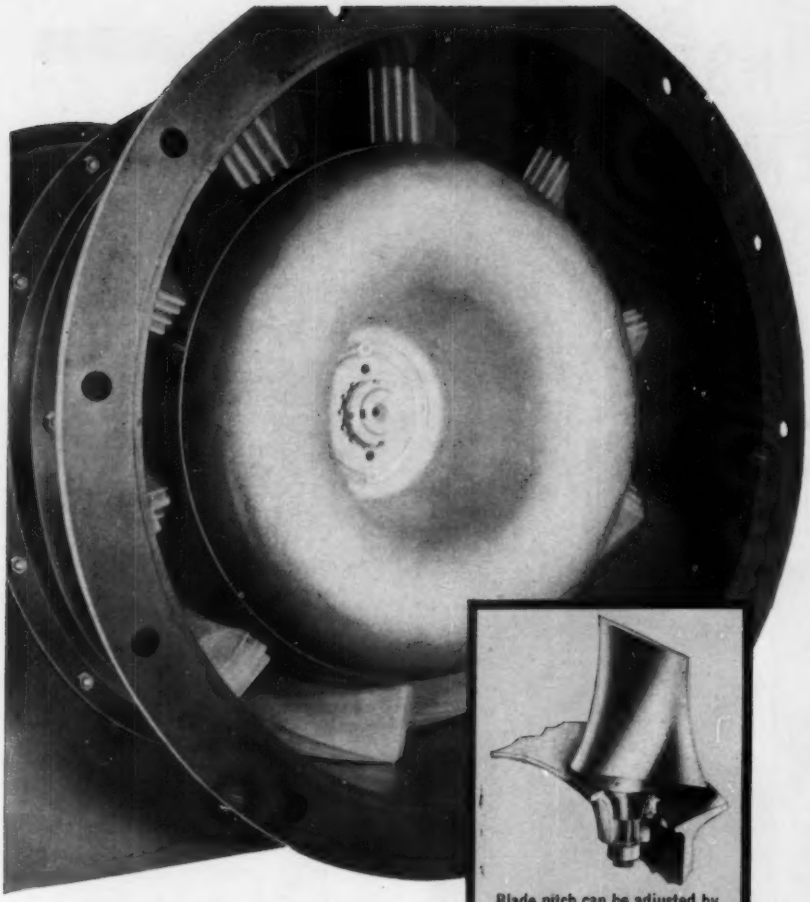
Originally developed for use on company's packaged d-c drives and mill processing line control, the mPac line encompasses 10 building block regulators. Completely static, these modules incorporate recent advances in fields of semi-conductor research and miniaturization, says manufacturer, and are ideal for control of motor or generator fields, speed regulators, current regulators, time rate or current limit control. Included among models are adjustable time reference unit; power supply; reference regulator; 15-v comparator; 30-v comparator; power amplier; cross-over



unit; adjustable current limit unit; low level current amplifier; and 6-v bias supply. Also available are magnetic amplifier field supply panels in five current ratings at 120 or 240 v d-c to provide power link between modules and motor or generator field. Publication ED-102 gives data. Cutler-Hammer Inc.

21—PIPE INSULATION, lightweight, for low temperature lines

Unarco U-200 is announced as a lightweight, rigid, urethane-foam pipe insulation for use at temperatures ranging from −300 F to 220 F. According to



Multiple exposure shows fan blades through the full range of pitch changes.

Blade pitch can be adjusted by loosening one nut, resetting the blade to desired position on calibrated scale, and retightening the nut.

Joy Design Means:

MINIMUM POWER CONSUMPTION WITH VARIABLE FAN OUTPUT

Blade pitch on Joy Axivane® Fans can be adjusted easily. This means that the volumetric output of Joy fans can be varied by as much as ± 20% without any sacrifice of fan efficiency, and therefore with minimum power consumption. The fan motor runs at its most efficient speed, regardless of the fan output, and there are no efficiency losses such as are encountered with dampers and variable inlet vanes.

Even at full load, Joy Axivane Fans are more efficient than propeller, tube-axial and centrifugal fans. The direct drive achieved by mounting the motors inside the fan housings eliminates drive losses, and the vane-axial design gives maximum aerodynamic efficiency. Mounting the motors in the housings also makes the Joy Axivane Fans more compact, and less costly to install.

Fans available range from types which weigh as little as a pound and have a diameter of a few inches, up to some which weigh tons and have diameters up to eight feet. If you need spot cooling, area ventilation, or any movement of air, Joy can supply the most efficient answer.

For complete information, write for Bulletin 1278-56C.

AIR MOVING EQUIPMENT FOR ALL INDUSTRY

JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

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Save... ON INSTALLATION AND REPLACEMENT COSTS *With* GOODALL *Rubber* EXPANSION JOINTS

Goodall Rubber Expansion Joints are flexible, durable connections for pipe lines and other equipment handling virtually all fluids and gases under pressure and vacuum, to prevent excess stresses due to expansion and contraction; to counteract vibration; and to insulate against undesirable sound. They can also be designed to overcome misalignment.

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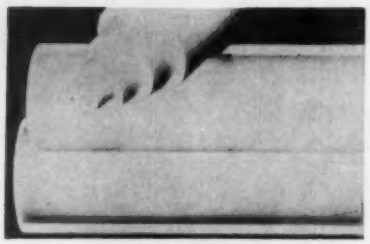

manufacturer, it has a K factor of only 0.14 to 70 F, and a density of only 2.3 lb per cubic foot, yet has high compressive strength. Claimed unaffected by most mastics and sealers normally used for cold insulation, U-200 is described as self-extinguishing and having no capillarity, and very low humidity, water absorption and hygroscopicity. The product can be cut to size and shape with hand tools. It comes in half-round sections 36 in. long, or in block form. Union Asbestos & Rubber Co.

22—DIAMOND DRILLS have air and electric drives

Optional, interchangeable air and electric drives are features of these two industrial diamond drills, both of 6-in. capacity. Model 330 (shown with electric motor) is a swivel drill, for drilling holes at any angle through reinforced concrete, brick, tile, or stone. It swivels in two directions, raises and lowers on a column attached to its base or can be

taken off its base and mounted on a column or horizontal crossbar. The mechanical advantage of the screw feed head lets operator apply necessary bit pressure with only moderate force on the hand crank. Model 305 is a lightweight vertical hole drill. For horizontal drilling, the screw feed mechanism can be removed from the base and anchored to the wall. Air motors (350-1500 rpm, 60 cfm, 90 psi) and electric motors (350–1000 rpm, 110 v) are all interchangeable. E. J. Longyear Co.

23—AIR CLEANER is high velocity, electronic unit

Up to 95 per cent efficiency while eliminating smoke, airborne dust and pollen in all types of ventilating systems is reported for the Hi-Velocity Electronic Air Cleaner. Based on the principle of "electrostatic precipitation", this cleaner charges the particles as they enter. Particles are then attracted and held by negatively charged collector plates. Both ionizing and collecting chambers are in the one, compact unit.

BOWATERS UTILIZES BY-PRODUCT WASTE AS FUEL

At Bowaters Carolina Corporation, Detroit RotoGrate Stoker, with 6 Detroit air swept spout refuse distributor feeders, installed under Babcock and Wilcox 2 drum single pass steam generator. Steam is produced at 850 psig, 900° F-T.T. Feedwater temperature 300° F. Combustion air temperature is 350° F.

Bowaters Carolina Corporation's new plant at Catawba, South Carolina uses a Detroit RotoGrate Stoker to burn bark refuse under a steam boiler. The installation is designed to produce 200,000 pounds of steam per hour when burning bark alone.

Costly waste disposal measures, which in years past were common to pulp mill operation, have been eliminated.

Provision is made for future firing of coal either in conjunction with bark or separately, and 275,000 pounds of steam will be produced with this combination. Peaks of 300,000 pounds of steam are anticipated.

Oil and gas burners in the furnace walls are presently used for auxiliary firing if refuse fuel is not available in sufficient quantity to supply the demand for steam.

Versatile in their ability to burn a broad variety of fuels . . .

DETROIT ROTOGRATE STOKERS

. . . have an established reputation for efficient performance.

8417

DETROIT STOKERS COST LESS: Cost equals initial investment plus upkeep plus production losses due to equipment outage. *The total is less with Detroit.*

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HAGATREAT

A **NEW** TREATMENT THAT SIMPLIFIES CORROSION CONTROL IN COOLING WATER SYSTEMS

NEW . . . Hagatreat not only controls corrosion, but also provides freedom from sludge or scale.

NEW . . . Hagatreat usually permits make-up water to be concentrated more in the cooling tower system, which means savings in both chemicals and water. Disinfecting is less difficult, too.

NEW . . . Several years of testing indicate Hagatreat will reduce steel corrosion to 1 or 2 mils per year; copper to less than a few tenths of a mil per year. No pitting tendency.

NEW . . . Hagatreat is easy to handle, may be fed in solutions containing up to one pound per gallon. Call on Calgon Company's technical service for complete information on Hagatreat and other cooling water treatment products.

A Calgon engineer will be glad to discuss your particular problems and prescribe both treatment and treatment routine. Write or phone:

CALGON COMPANY
HAGAN BUILDING, PITTSBURGH 30, PA.

DIVISION OF **HAGAN** CHEMICALS & CONTROLS, INC.

For more data circle 545 on Post Card

This lightweight construction permits overhead mountings where necessary, it is pointed out, and high-voltage leads

may be made from the front for convenience and safety. The cleaner comes in six models, field assembled or in cabinet form. Dollinger Corp.

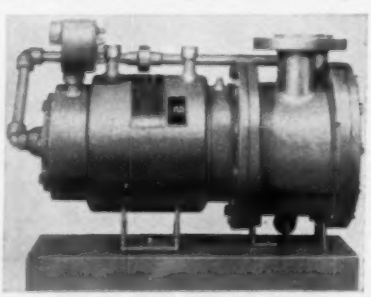
24—BUTTERFLY VALVE is removable, cartridge type

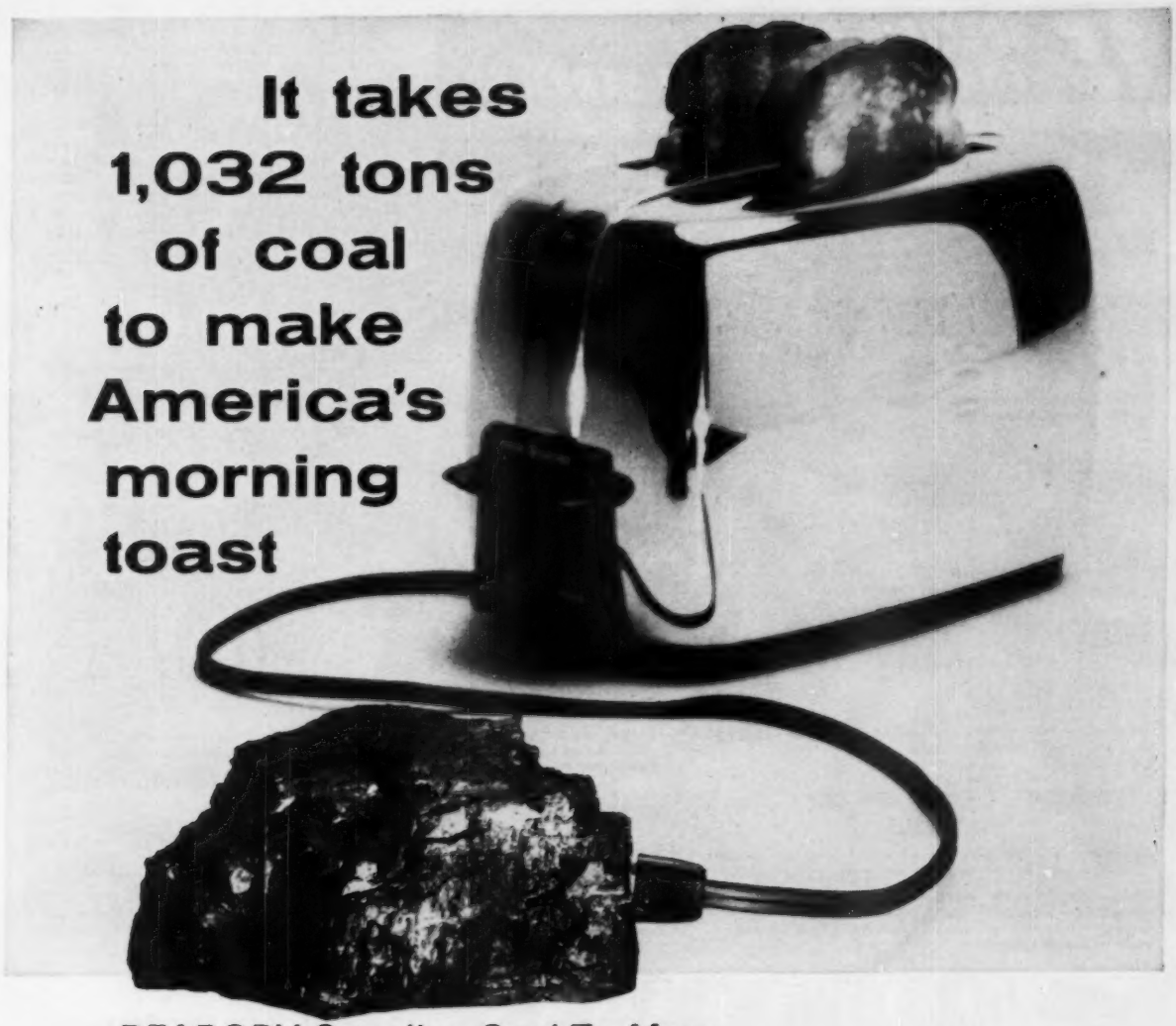
This cartridge unit consists of a standard butterfly valve in a wedge shaped body which is inserted in the outer body and held in place with the cover. Its

flow characteristics are claimed identical to the standard two-flange valve. If necessary, the wedge shaped insert can be removed without disturbing the line flanges or the piping. Cover of valve and shaft extension accommodate standard manual, diaphragm, motor or cylinder operators. Allis-Chalmers Mfg. Co.

25—CANNED PUMPS, two-stage high head units

Series D Chempumps are designed for leakproof pumping at heads to 600 ft, and offer advantages of canned pumps. Rotor, shaft and impellers form a single





PEABODY Supplies Coal To Many Of America's Leading Electric Utilities

At breakfast this morning, when that rich golden-brown toast was served and its wonderful aroma drifted up from your plate . . . you probably didn't realize that every morning, 1,032 tons of coal is used to make the nation's toast.

Day and night . . . in our homes, offices and plants—in countless ways . . . coal serves us by generating dependable, economical electrical power. Coal's importance to the nation is best emphasized by the fact that *coal* generates more electricity than all other fuels and water power *combined.* Peabody Coal Company . . . with two billion tons of proven reserves . . . supplies many of the nation's electric utilities that bring you efficient, dependable power . . . at a price you can afford to pay.

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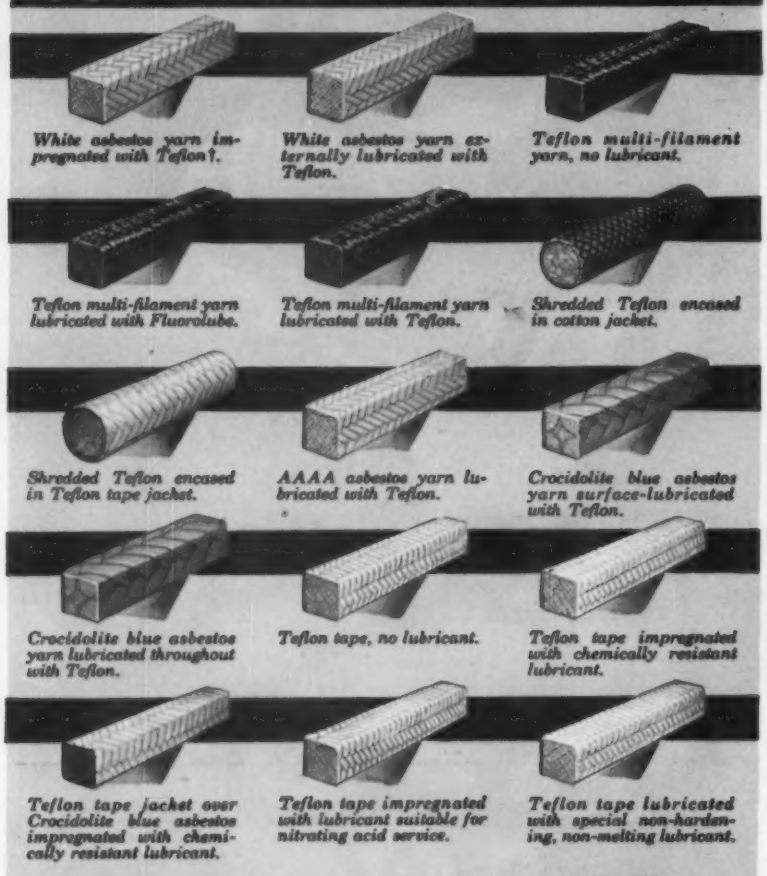
15 SPECIFIC PACKINGS FOR ALL CORROSIVE SERVICES


White asbestos yarn impregnated with Teflon†.
White asbestos yarn externally lubricated with Teflon.
Teflon multi-filament yarn, no lubricant.
Teflon multi-filament yarn lubricated with Fluorolube.
Teflon multi-filament yarn lubricated with Teflon.
Shredded Teflon encased in cotton jacket.
Shredded Teflon encased in Teflon tape jacket.
AAAA asbestos yarn lubricated with Teflon.
Crocidolite blue asbestos yarn surface-lubricated with Teflon.
Crocidolite blue asbestos yarn lubricated throughout with Teflon.
Teflon tape, no lubricant.
Teflon tape impregnated with chemically resistant lubricant.
Teflon tape jacket over Crocidolite blue asbestos impregnated with chemically resistant lubricant.
Teflon tape impregnated with lubricant suitable for nitrating acid service.
Teflon tape lubricated with special non-hardening, non-melting lubricant.

John Crane CHEMLON *BRAIDED PACKINGS

Specific service conditions are always best handled with a packing designed for the purpose. This is especially true when it comes to the hard-to-handle liquids.

For this reason John Crane has developed 15 individual field-proved types of Chemlon Braided Packings. Within this line there is a type and style that will meet any combination of service conditions and requirements.

1. All known industrial acids, alkalis or solvents.
2. Temperatures from −120°F to +600°F.
3. High or low shaft speeds, also valve stems.
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Send in your service condition and we will recommend a Chemlon Braided Packing best suited to your application. Request Bulletin P-325.

Crane Packing Co., 6429 Oakton St., Morton Grove, Ill. (Chicago Suburb).
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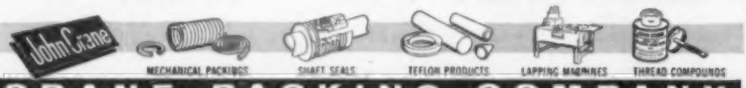
†*T. M. for DuPont Teflon* **T. M. for the Best in DuPont Teflon*



CRANE PACKING COMPANY

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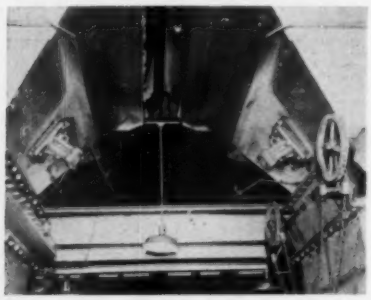
rotating assembly; rotor and stator are enclosed or "canned" within corrosion-resistant, non-magnetic alloy cylinders. Pumped fluid is allowed to circulate through the motor section and serves to cool the motor and lubricate the bearings. Low temperature Series D Chempumps, for operation under 400 F, are equipped with water jackets around the stator for cooling if required. High temperature models for handling fluids over 400 F. have external heat exchangers. The pumps are available for temperatures to 850 F, system pressures to 3500 psi. Chempump Div., Fostoria Corp.

26—AIR VIBRATOR keeps the coal moving along

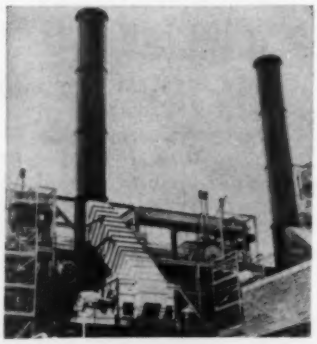
The BH-3 Long-Stroke Air Vibrator is designed to keep even high-moisture content coal moving briskly. It is made to dislodge arched material with a direct, timed long piston stroke. Of one-



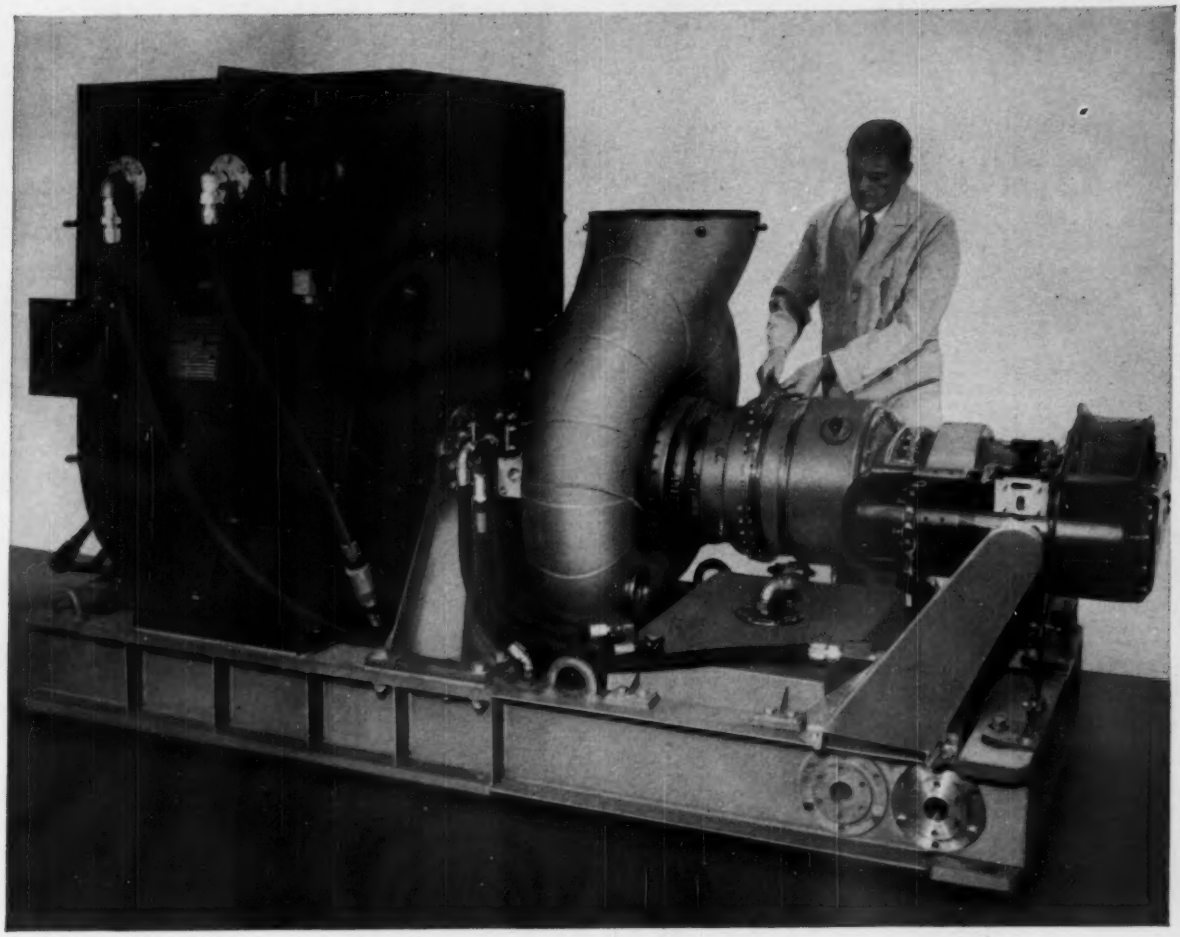
piece design, the base plate is an integral part of the body, and piston is the only moving part. According to manufacturer, units can be used in hazardous atmospheres, under extreme moisture conditions, on outside applications in inclement weather, and in locations where magnetic dusts exist. National Air Vibrator Co.

27—COLORED SMOKESTACKS glass lined inside and out

Glass protection for steel smokestacks is now available in a variety of custom colors, as well as shiny black and cobalt blue. The process utilized permanently fuses the color dyes into the stack's glassed exterior. It more effectively dresses up a smokestack than painting,



says company, because temperature and weather conditions have little or no dulling effect on the shiny colored glass, and corrosion cannot be hidden by a layer of paint. A. O. Smith Corp.



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Electrical generator driven by new Solar Saturn *industrial gas turbine offers unequaled fuel efficiency, outstanding performance*

SOLAR'S REMARKABLE NEW 1100 hp industrial gas turbine sets new standards of performance as a power source for marine and industrial generators. The engine is extremely lightweight, averaging 1/10th the weight of conventional engines of similar horsepower. It occupies only 51 cubic feet. It starts instantly (an advantage of significant importance in generator applications). And it takes full load without laboring, even after long periods of standby service. In addition, Solar's *Saturn* industrial gas turbine offers fuel efficiency unequaled in its field.

As a dependable power source for generators and compressors, as a propulsion unit for high-speed boats and in other applications... Solar gas turbines are saving time and money. For information about Solar's family of 50 to 1100 hp gas turbines, write to Dept. C-182, Solar Aircraft Company, San Diego 12, California.

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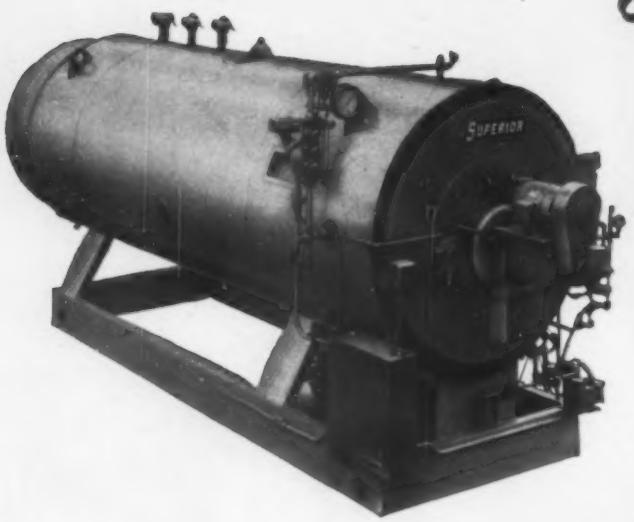

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Many packaged boilers will meet *some* of the specifications listed here. Superior Packaged Boilers meet them ALL. Today, more and more packaged boilers are being purchased on the specifications of architects and consulting engineers. Those consulting engineers are demanding that packaged boilers "measure up" to design and performance standards which assure buyers both operating economy and long-lived dependability.

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REFRACTORIES AND INSULATION

201 **Refractory Cement** — Heavy duty brick bonding and patching mortar is described in this 8-pp illustrated color folder. Includes success stories concerning the product's application in high temperature work and in the protection of equipment against slag, fly ash and gases. Refractory and Insulation Corp.

202 **Insulation Specifications** — This 50-pp manual of specifications, IN-128A, is designed for the power, chemical and petroleum industries. It is divided into five sections — insulations for temperatures above 100 F; those for temperatures below 100 F; tank insulation; sphere and spheroid insulation; regenerator, catalytic reactor and oil heater lining and insulation. Tables include recommended thicknesses for both steam generating plants and process equipment based on average economic conditions for the industries and recommended thicknesses of insulation to prevent sweating. Johns-Manville.

203 **Pipe Insulation** — Featured in brochure J-432 is a lightweight, flexible, one-piece pipe insulation composed of incombustible, moisture-resistant mineral wool fibers, bonded with a phenolic resin and molded into 6-ft long sections. Characteristics of the material are described. Baldwin-Ehret-Hill, Inc.

BOILERS, GENERATORS

204 **Package Boilers** — This 12-pp booklet on package steam generators describes the formulas behind all package steam generators, and illustrates how installation of a package steam generator can raise steam capacity in an existing boiler room. Cyclotherm Div., National-U. S. Radiator Corp.

206 **Automatic Boiler** — Application of the Coal-Pak automatic package boiler to low-pressure steam heating, hot water heating, and high-pressure process steam is covered in 36-pp Guide Specifications GS-3. Sample specifications include coal and ash handling, wiring, and boiler room layouts. Bituminous Coal Institute.

207 **Packaged Boiler** — Features and advantages of a completely packaged boiler for installations requiring capacities from 11,000 to 61,000 lb of steam per hr are detailed in this 12-pp bulletin. Cutaway views and diagrams showing details of design and construction are included and data table. Superior Combustion Industries, Inc.

208 **Steam Generator** — Bulletin F-14 contains 32 pp of detailed information on company's water tube type steam generator. Photos and diagrams illustrating design and construction features are included. E. Keeler Co.

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25	26	27	28	143	144	145	146	147	148	149	267	268	269	270	271	272	273	274	275	276	277
29	30	31	32	150	151	152	153	154	155	156	278	279	280	281	282	283	284	285	286	287	288
33	34	35	36	157	158	159	160	161	162	163	289	290	291	292	293	294	295	296	297	298	299
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The unique "Maxisafe®" Duragauge provides absolute protection to the viewer, plus easy and quick access to the mechanism. Your industrial supply distributor will help you select the best combination of components for your Ashcroft Gauge requirements. Phone him today or write for Catalog 300B.

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MODEL CC-475 heat exchanger and condenser tube cleaner. Weighs just 11 pounds for easy one-man operation without supporting rig. Air-motor driven to deliver all the power needed for cleaning clogged tubes up to 1 inch in diameter. Built-in flushing system keeps drill head cool and tubes clear.

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type are presented in 12-pp Bulletin 117-A. Construction and operational features of the heaters are explained and illustrated, and more than a dozen available models are pictured along with application suggestions. Stickle Steam Specialties Co.

220 Corrosion Control Tips — Control of water problems in air conditioning system — scale formation and slime and algae growths — is discussed in Bulletin 596. Offers suggestions for the control of these problems through adequate, planned chemical treatment. Application information as well as control testing data are included. Betz Laboratories, Inc.

221 Condensate Corrosion Control — Advantages of company's film-type amine for controlling corrosion in steam condensate systems are detailed in Bulletin 410. Typical applications are described. Hagan Chemicals & Controls, Inc.

COAL AND ASH HANDLING

223 Shredders, Crushers — Bulletin 257 describes and illustrates hammermills and shredders, rolling ring and special crushers for reducing chemicals, minerals, ceramics, and other materials including wood waste. Discusses construction features. American Pulverizer Co.

224 Volumetric Feeder — Eight-pp Form 161 describes volumetric belt feeders designed to provide unrestricted coal flow to pulverizers and to cyclone burners. Includes data on types, sizes, capacities, and illustrates belt changing method. Stock Equipment Co.

225 Crawler Tractor — The HD-16 crawler tractor powered by the 16000 engine is described in Catalog MS-1318, 14-pp. It includes cutaway of the tractor, diesel engine's combustion chamber, track release mechanism and hydraulic dozer control unit. Matching equipment is pictured and described; attachments, listed. Allis-Chalmers Mfg. Co.

TUBING AND ACCESSORIES

226 Tubes and Plates — Publication B-2, 46 pp, covers the subject of tubes and plates for condensers and heat exchangers. Field of application and particular problems encountered in each are described. Information on condenser tube alloys, plates for tube sheets and baffles, manufacturing methods, installation, operational factors affecting tube life, corrosion factors in condenser tube service is presented. The American Brass Co.

227 Tube Cleaner — Featured in Sheet A-24 is a condenser and heat exchanger tube cleaner weighing only 10 lb. Operation advantages are detailed and specifications listed. Airetool Mfg. Co.

228 Tube Expanding — The technique of tube rolling in thick tube sheets is discussed in Bulletin Y-52. Various methods of rolling are detailed, and advantages of continuous rolling described. Elliott Co., Div. Carrier Corp.

229 Tube Cleaners, Expanders — Comprehensive information on maintenance tools for all types of tubular equipment is presented in 120-pp Catalog 77-88. Includes detailed suggestions on selection of tube cleaning equipment for various applications, data on condenser tube cleaners, vibrator cleaners for fire tube

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Time and labor saving almost unbelievable. No individual trowelling and bonding. No exacting operations. One 9" x 13½" x 13½" FURNACE BLOK equals the volume of sixteen standard 9" firebrick.

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No brick-to-brick joints. Less spalling. Better insulating value. Lower heat storage.

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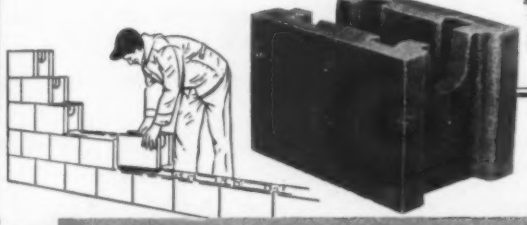

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boilers, other boiler tube cleaners, water driven cleaners, vapor generator tube cleaners, wire brushing equipment, tube cleaner hose, lubricator, valves and manifolds, electrically driven cleaners, chipping and surfacing machine. Book is available to qualified power engineers. Thomas C. Wilson, Inc.

TURBINES, ENGINES

230 Steam Turbines — The advantages of company's solid wheel turbines, axial flow turbines, single stage and multistage, are outlined in illustrated Bulletin S-140. Describes various models in their line and includes application photos. The Terry Steam Turbine Co.

231 Gas Turbine Engines — Featured in this 24-pp bulletin are engine data, performance curves and applications for company's gas turbine engines. Explains operation of gas turbines and includes photos showing applications, as well as engineering diagrams. Solar Aircraft Co.

232 Steam Turbines — Single stage turbines for mechanical drives are featured in 6-pp Bulletin T-126. Schematic drawings showing component features and details of operation and design are included. Murray Iron Works Co.

VALVES, TRAPS, PIPING AND FITTINGS

233 Safety, Relief Valves — Performance data on company's safety and relief valves is presented in 24-pp Catalog 1000-V. Steam, air and water capacity tables are included, as well as cutaway views showing component details, and dimension tables. J. E. Lonergan Co.

234 Boiler Blow Off Valves — Bulletin E-125, 24 pp, describes and illustrates the design and construction of company's quick-operating valves, angle valves, Y valves and duplex units specifically designed for boiler blow-off service. Includes dimensions. Everlasting Valve Co.

235 Steel Globe Valves — Low-pressure-drop cast steel globe valves for large volume, high pressure and/or high temperature applications are described in 16-pp Catalog 14-B. Advantages are detailed and cutaway view showing construction features included, as well as pressure ratings, dimensions and weights, material specifications, correlation of valve size and pressure drop. Edward Valves, Inc.

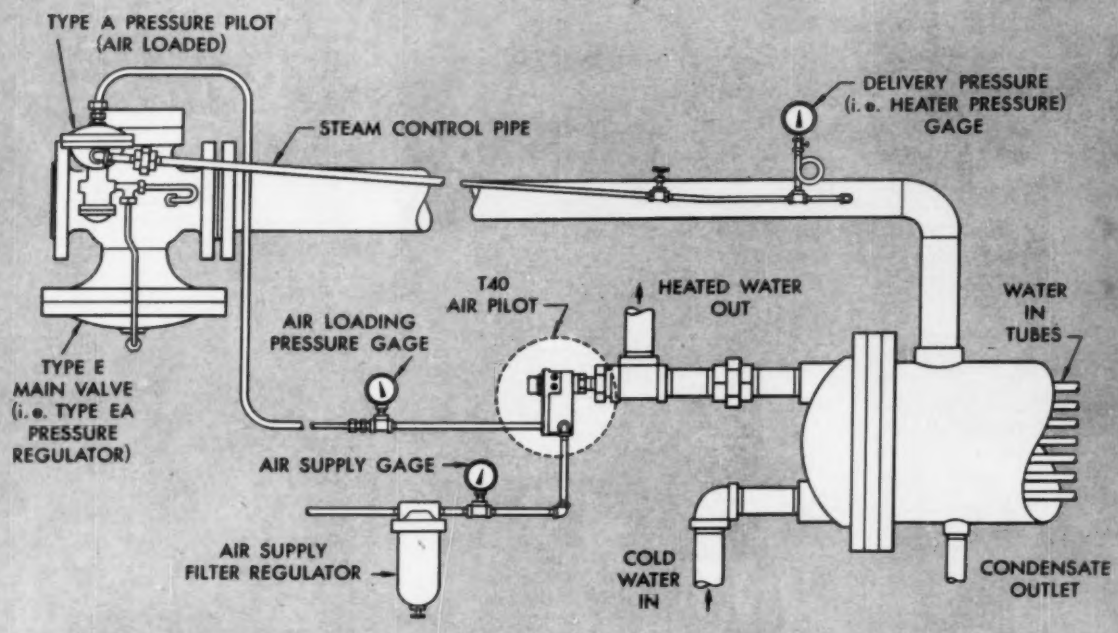
236 Bronze Gate Valves — Presented in this product bulletin, Form 198, is a line of bronze union bonnet gate valves for 125 to 150 WSP. Features are shown on cutaway view, and dimension given in tables. The Wm. Powell Co.

237 Silent Check Valves — Described in Bulletin WH-654 are silent check valves featuring low frictional resistance. Tables list dimensional data and reasonable velocities for flow of water through pipe, fittings, and valves. The Williams Gauge Co., Inc.

PACKINGS, GASKETS

240 Mechanical Packings — Catalog P-210C contains 40 pp of detailed information on company's line of mechanical packings and gasket materials. It contains

New Spence Temperature Control System Gives Unusual Control Accuracy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HEATED WATER OUT
WATER IN TUBES
AIR LOADING PRESSURE GAGE
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COLD WATER IN
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TYPE EAT40 AIR-CONTROL TEMPERATURE REGULATOR

In a recent installation the new Spence air-control temperature regulating system provided:

- ±5°F control accuracy under wide and instantaneous load swings of 210 to 80 gallons per minute.
- Up to 50% reduction in cost as compared to instrument systems of similar accuracy.

This unique cascade-type control with throttling range adjustment independent of maximum heater pressure was developed to meet today's demand for greater control accuracy.

Additional features of the new Spence Temperature Control System include:

- 200°F wide adjustable temperature range
- Adjustable speed of steam pressure change
- Over and under temperature protection
- Pressure limit control
- Fast response
- Very low air consumption
- Field reversible for heating or cooling

The Spence Type EAT Air Control Temperature System, when properly installed, will tame wide ranging, fast changing loads of instantaneous heaters and modern heat exchangers. The cascade principle plus the use of an extremely fast responding bi-metal temperature sensing element reduce time lags and provide control stability.

Here's how the new Spence system operates:

Quick response is based on a bi-metal temperature sensing element.

Temperature pilot continuously regulates a loading air pressure.

This loading signal, when applied to a pressure regulator to reflect heater temperatures, causes it to adjust the main valve as changes in load require.

Spence has also developed a new pressure control system based on this same cascade principle. This system has a control accuracy of ½ psi or better from positive pressures through the vacuum range to 30" Hg.

For complete information on these new air controlled temperature and pressure control systems, write for your copy of Bulletin 9.

SPENCE ENGINEERING COMPANY, INC.
Walden, New York

SE-140

For more data circle 554 on Post Card

While flow goes through this compartment
This one is closed for cleaning. Back-flushing water enters at side, drains at bottom.

Twin Strainer with special back-flushing feature

Elliott Twin Strainers are built in two types. With Type A, one strainer basket is removed and dumped, while liquid flows through the other basket. Type A strainers are also built with a back-flushing feature, whereby the closed-off compartment is cleaned by reversing the liquid flow. Flushing and draining connections permit liquid to enter side of compartment, flow through basket and drain at bottom. Type V, with large-size baskets, is designed primarily for handling oil and viscous liquids.

For over 50 years, Elliott Strainers have been effectively removing objectionable solids from water and other liquids. The resulting trouble-free service has led to installations in power and industrial plants all over the country. Elliott also makes Single Strainers, one type having an Automatic Self-Cleaning feature, the other type with a removable basket for manual cleaning. For details call your Elliott District Office or write Elliott Company, Accessories Department, Jeannette, Pa.

A7-1

ELLIOTT Company

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

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illustrations, descriptions, complete service recommendations and specification charts. Raybestos-Manhattan, Inc.

242 Mechanical Packings — Service and technical details on chemically-inert Teflon packings are provided in 8-pp Bulletin P-325 covering company's Chemlon line. Presents 15 types of braided construction, rings, six types of molded construction, cup and cone rings, combination sets. Gives recommendations as to services, applications and temperatures, also information on pressures, dimensions, mechanical requirements. Crane Packing Co.

PUMPS AND COMPRESSORS

243 Vertical Turbine Pump — Featured in 16-pp Bulletin 2400-B1 is a line of ultra high flow vertical turbine pumps. Design improvements, which result in broader coverage and higher efficiencies over wider operating ranges, are illustrated and described. Worthington Corp.

244 For Abusive Pumping Jobs — Catalog 5206 covers centrifugal pumps for wide industrial use and especially adapted to handling ashes, abrasive mixtures, slurries, hot and corrosive liquids. It describes several basic types: a horizontal shaft, single-stage side suction pump; a horizontal shaft, single-stage, rear-entrance automatic priming pump; vertical shaft pumps with standard, overhead and quill bearings for wet pit applications. Nagle Pumps.

245 Chemical Feed Systems — Bulletin 558-3 describes a line of controlled volume pumps and accessories for feeding water treatment chemicals. Design and construction features are detailed, and specifications given. Milton Roy Co.

246 Air Compressors — Stationary air compressors for continuous, heavy duty service in industry are illustrated and described in Bulletin A-62. Contains specifications, diagrams, cross section drawings, and installation photos. Joy Mfg. Co.

INSTRUMENTS, CONTROLS

247 Metering Control Systems — Bulletin 500 describes purpose, design and operation of company's metering and control systems. Includes discussion and pneumatic control, along with detailed literature references. Bailey Meter Co.

248 Instruments and Controls — Catalog 57-6 describes instruments and controls, including flow meters, liquid level or pressure gage, CO_2 meters, boiler meters, pneumatic transmitters, strip chart recorder, pressure, vacuum and differential recorders, temperature recorder, multipoint gages and others. Includes descriptive data. Republic Flow Meters Co.

249 Controls Data — Comprehensive data on all types of controls, including diaphragm valves, pilot controllers, regulators, safety heads and tank vents are presented in this loose leaf notebook. Individual sections contain all pertinent information on each specific product, including descriptive details and engineering data, dimensions, specifications. Application and operation details are fully illustrated. Black, Sivalls & Bryson, Inc.

252 Water Level Gages — Twelve-pp Bulletin WG-1815 describes company's color-port gages for medium boiler pres-

sures to 1050 psi, and high pressures to 3000 psi. Details of gages, water columns, color-port inserts, and gage valves are given, with dimensions, data on transmittal of readings, and servicing instructions. Yarnall-Waring Co.

253 Pump Pressure Regulator — Bulletin 5306 contains 16-pp of detailed information on company's constant and differential pump pressure regulators for controlling steam to a reciprocating steam pump or turbine-driven pump. Tables of pressure ranges are included, along with sizing and steam consumption formula, and capacity data. Leslie Co.

255 Ideas on Push-Pull Controls — Included in this "Idea File" are answers to a power engineer's questions on the use of push-pull controls. A general information booklet discusses remote control applications, explains construction and operation of company's Tru-Lay controls. Separate bulletins are devoted to standard assemblies, bracket-type head controls. Automotive and Research Div., American Chain & Cable Co., Inc.

257 Analog Computer Control — Bulletin MSP-163 contains detailed information on a solid state, magnetic analog computer for industrial process control applications. Describes basic elements of the control and diagrams some interchangeable circuits possible with various components. Hagan Chemicals & Controls, Inc.

258 For Wet Salt Storage — A water control system designed specifically for wet salt storage is described in this 8-pp booklet. Advantages of the automatic control are covered, and diagrams of various assemblies included. Morton Salt Co.

259 Instrument Tubing — Detailed information on various types of instrument tubing and accessories is presented in this 16-pp bulletin. Among tubing described is extruded polyethylene tubing, extruded nylon tubing, tubes of copper, aluminum, and/or steel with polyethylene sheath, tubing with vinyl sheath, bundled instrument tubing. Dekoron Products Div., Samuel Moore & Co.

DUST CONTROL

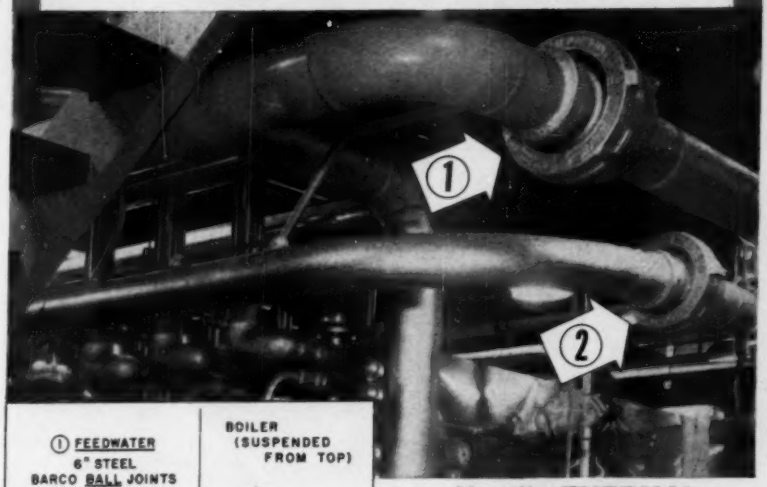
260 Dust Control Unit — Featured in Bulletin V-100 is a conditioner unit for dust control, designed to apply rapid, on-the-spot conditioning to dust materials in all types of handling. Principles of operation are described in an accompanying engineering data bulletin, Bulletin V-101. The Johnson-March Corp.

261 Dust Collection and Recovery — A series of product bulletins on company's line of dust collecting, precipitation and gas scrubber equipment is available in this literature folder. Among the equipment described are electrical precipitators, mechanical dust collectors, gas scrubbers, high temperature dust collector, reverse-jet equipment, rapper control, fly ash collector, transistomatic precipitator control, and related equipment. Western Precipitation Corp.

ELECTRICAL EQUIPMENT

262 Synchronous Motors — Advantages of company's high speed synchronous motors are detailed in 12-pp Bulletin 501. Cutaway view illustrates component parts and details of maintenance and operation.

. . . where BOILERS move UP and DOWN



Handle THERMAL EXPANSION with BARCO Ball Joints

The schematic diagram at left shows how Barco Flexible Ball Joints of steel construction are used in a new Florida utility plant—design pressure 600 psi, 500°F. The above photo shows a close-up view of two of the joints (see arrows). Two more matching joints, 4" and 6", are located out of the picture to the left. The 4" joints have metal gaskets. The same utility also uses 10" Barco joints on gas fuel lines. Other uses in power plants are for flexible connecting lines to oil burners, soot blowers, and other auxiliary equipment.

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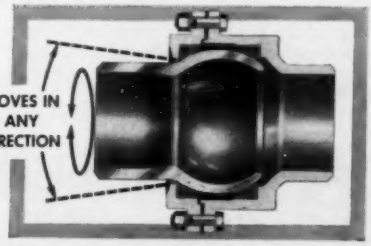
Solves Piping Problems!

The rapidly increasing use of Barco Flexible Ball Joints for solving piping problems in POWER PLANTS is significant for several key reasons:

1. Substantial *space saving* as compared to other methods in crowded piping areas.
2. Unlimited flexibility and movement. Utmost simplicity.
3. No heavy pipe anchoring required. No "end thrust" developed under pressure.
4. Ability to handle compound movement (where twisting is combined with thermal expansion and contraction).
5. Easy to engineer joints into piping to provide for any degree of flexibility, expansion, or movement required.
6. Maximum safety for high temperature applications. All-metal construction available. Special alloys can be specified.
7. Basic design is pressure sealing against leakage and self-adjusting for wear.
8. Virtually no deterioration. Able to stay in service for years without repairs or maintenance. No lubrication.

New Bulletin No. 31 contains interesting diagrams showing how to solve many common pipe expansion problems EASILY, ECONOMICALLY. *Ask for a copy;* see your nearest Barco representative or write:



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BD Softeners contain only high capacity Permutit Q Resin. Absence of subfill eliminates possibility of upsetting bed, makes installation simpler, less expensive. Exclusive double-dish underdrain is shipped completely assembled, further simplifies installation. Standard valve is the famous Permutit Multiport® type.

Permutit Model BD Softeners are available in the following sizes and capacities:

Shell Diam.	Straight Ht.	Flow Rate Average	Softening Capacity
30″	6′	40 gpm	510 kgr
36″	6′	56 gpm	750 kgr
42″	6′	77 gpm	1020 kgr
48″	6′	100 gpm	1380 kgr

For specifications and complete information, write to our Permutit Division, Dept. PE-30, 50 West 44th Street, New York 36, N.Y.

*FLUIDICS is the Pfaudler Permutit program that integrates knowledge, equipment and experience in solving problems involving fluids.

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Applications and specifications data included. The Ideal Electric & Mfg. Co.

263 Dielectric Test Set — Bulletin 22-5 describes an instrument in bench and portable models for making step-voltage-current (or resistance) tests, voltage withstand and breakdown tests on the insulation of electrical equipment with ratings of 300, 600, 2500 v and higher. Specifications and prices are included, also outline of design and operating features of the instrument. James G. Biddle Co.

264 Commutator Maintenance — This commutator and slip ring maintenance data file contains information on methods and procedures for more efficient commutation. Individual bulletins cover brushes, sparking, picking, dragging and other troubles, maintenance tools and how to use them. Ideal Industries, Inc.

Postage-free cards for ordering catalogs are on page 106. You may also use the cards to order literature mentioned in the ads.

265 Cable Troughs — This 28-pp catalog offers a simple solution to any design problem of change of direction or elevation with a complete set of standard fittings, horizontal elbows, inside and outside vertical elbows, ties, crosses, covers and special devices. The Globe Co.

VENTILATING, REFRIGERATION AND AIR CONDITIONING

267 Refrigeration Condensers — Engineering data on a complete range of sizes and types of refrigeration condensers are featured in 38-pp Bulletin RC-2. Ratings in tons refrigeration are tabulated for large and small ammonia condensers, vertical ammonia condensers, ammonia condenser-towers, freon condensers and freon condenser-towers. Selection data, dimensions given. Henry Vogt Machine Co.

269 Refrigerated Purging — Helpful data on purging refrigeration systems is presented in 12-pp Bulletin 700. Covers basic principles of automatic purging, selection, installation and operation of purgers, and specifications. Armstrong Machine Works.

270 Zone Control Cabinets — Illustrated and described in 20-pp Bulletin AC-220 is a line of sectionalized easy-to-assemble units with separate fan section, coil section, zone dampers and optional accessories. Includes physical data, dimensions, fan performance tables, coil ratings, and selection data. Buffalo Forge Co.

271 Heating, Ventilating Cabinets — Construction features and performance details on company's line of heating and ventilating cabinets are illustrated and described in 16-pp Bulletin UH-130. Contains unit arrangements, physical data, weights, fan performance, dimensions, coil ratings. Buffalo Forge Co.

OTHER EQUIPMENT

272 Story of Coal — This pocket-size booklet presents a complete picture of company's operations, traces the history of the coal industry and describes the many services and applications of coal. A color-

ful mural reproduced in the booklet pictures the part coal has played in civilization. Peabody Coal Co.

273 Cranes, Hydro Equipment — Twelve-pp Brochure HY-51 describes cranes and equipment for hydroelectric, water supply and other applications. Various components and assemblies that help harness hydroelectric power are pictured, including cranes and hoists, gates and valves, and special hydroelectric equipment. Yuba Consolidated Industries, Inc.

274 Struts, Snubbers — Eight-pp Catalog 229A describes and illustrates ball-type flexible struts for structural applications and Vibrasnub hydraulic vibration snubbers. For each product line, catalog explains operation, provides specifications and illustrates engineering applications. Also discusses advantages of the flexible struts and includes design and installation notes. Barco Mfg. Co.

275 Cooling Towers — Performance details on company's cross-flow cooling towers are presented in this 20-pp illustrated Booklet CF-59. Discusses and illustrates through diagrams the cross-flow principle of water cooling, and includes descriptions of equipment, engineering and design features. The Marley Co.

276 Soot Blower — Bulletin 1091-A describes features and advantages of company's automatic soot blower for efficient boiler cleaning. Operation details are diagrammed and data given. Diamond Power Specialty Corp.

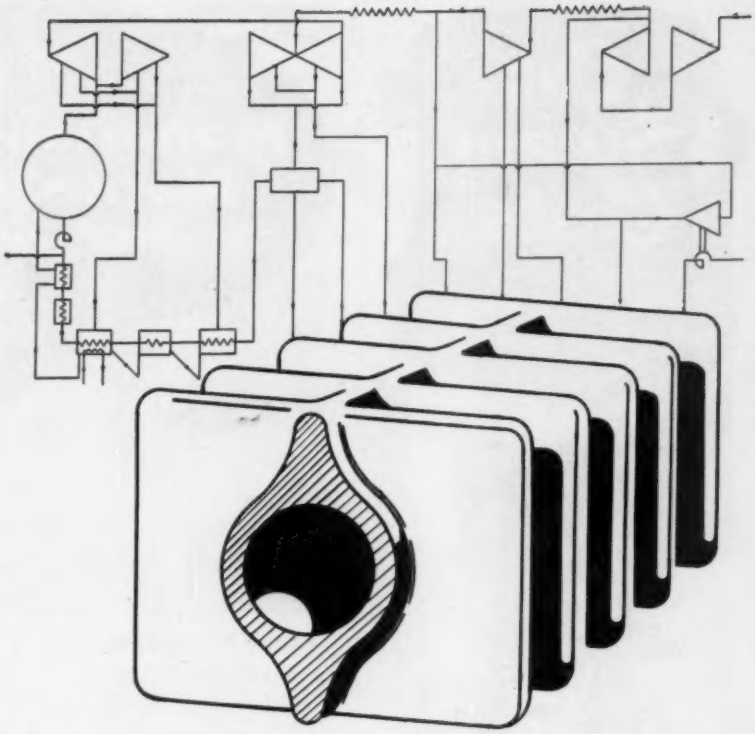
277 Air Preheater — Featured in this 14-pp booklet is a line of package air preheaters for small boilers and process applications. Fuel savings data is presented, as well as diagrams of typical arrangements, and other details of design and operation. The Air Preheater Corp.

278 Corrosion, Abrasion Control — Modern practices and products for the positive protection of metal equipment from the effects of corrosion and abrasion are described in this 16-pp bulletin. Covers factory and field application of rubber or synthetic linings to metal parts or products, and maintenance coatings available. Goodall Rubber Co.

279 For Chemical Cleaning — Technical Bulletin 102, about 16 pp, presents application and other information on company's products for chemical cleaning. These include formulas for power plant cleaning, stainless-steel cleaning, aluminum and aluminum alloy cleaning, alkaline derusting and paint stripping, general cleaning, others. Also provided is chart of corrosion rates. Chas. Pfizer & Co., Inc.

280 For Desuperheating — Bulletin 1056 describes a carburetor-type desuperheater capable of being controlled to supply steam at a temperature within ± 5 F of plant requirements. Explains method of control and gives range of control attainable. Also describes structural details, system arrangements of components, and mechanical specifications. Copes-Vulcan Div., Blaw-Knox Co.

281 Aluminum Jacketing — Advantages of protecting insulation with aluminum jacketing are detailed in this illustrated product bulletin. Increased efficiency and reduced heat-loss are noted, and typical installations of jacketing are pictured. Childers Mfg. Co.



Green's Low-Level Economizer belongs on your steam cycle flow diagram!

Why has Green's Low-Level Economizer already been purchased for inclusion in several large units scheduled for operation in 1960, 1961 and 1962?

1. It is accepted that low-level heat recovery offers the most economic method of obtaining the lower heat rates required today.

2. Flue gas-to-water heat exchange transfers the low temperatures from the airheater to the Low-Level Economizer where the problems of corrosion and plugging can be adequately resolved.

Green has had over 100 years of economizer experience. It is yours for the asking.

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BEACON 3, NEW YORK

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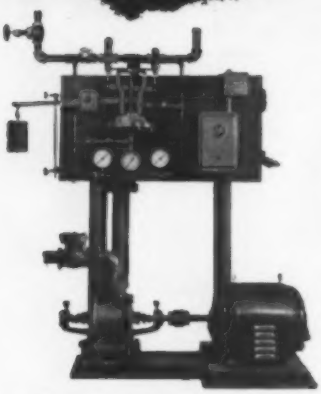
Cut Steam Costs

with Stickle's differential drainage and boiler return system



A closed pumping system for returning condensation from heating and processing equipment under pressure directly to boiler at temperatures only 15 to 20 degrees lower than those at operating pressure. For plants using steam pressures between 50 and 250 lbs. Cuts the cost of steam these eight ways:

1. Cuts fuel costs 10% to 25% by completely salvaging condensate and returning to boiler at 300 degrees or higher.
2. Raises production with higher, more uniform boiler pressure, higher temperature steam.
3. Reduces use of raw make-up water 85% to 90%.
4. Cuts maintenance on boilers, steam lines, traps and valves.
5. Improves quality by permitting operation of processing units at peak efficiency.
6. Cuts power used for pumping up to 75%, since system requires only 25 lbs.
7. Automatically maintains positive circulation without steam loss.
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Cuts the cost of steam

Steam Traps • Feed Water Heaters
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Drainage and Boiler Return Systems

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Monoflange Mark -II
the versatile valve

the ideal valve for

0–150# water service lines. Simple and reliable. Drop-tight shutoff. Pratt quality throughout.

For complete description, fluid and gas flow data, operator sizing, and prices, write for Bulletin 10G.

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ANSWER

to Worthington "Hidden Value" Puzzle on Back Cover

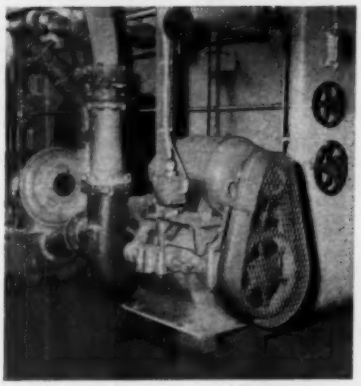
The fictitious "hidden value" is *Adjustable Roller Main Bearings*. The design of any balance opposed compressor makes roller bearings impractical from a maintenance standpoint. Worthington balanced opposed compressors use centrifugally cast sleeve bearings which can be removed for inspection or maintenance without disturbing the crankshaft or removing the connecting rod from the frame.

It's NAGLE PUMPS for Economical Ash Handling!

Nagle Ash Handling Pumps have wide, non-clogging impellers, and employ tough manganese steel or hard chromium alloys to resist abrasion. Slippage seal and stuffing box adjustments take only minutes and are readily accessible.

If your power plant burns solid fuel, Nagle Pumps will provide ash disposal with maxium economy.

The 6" type "TR" Nagle Ash Pump shown, with motor overhead to conserve space, is aboard the S. S. Harry Coulby, of The Interlake Steamship Company, operating on the Great Lakes. Send for Catalog 5206.



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Long-established manufacturer of steam and machinery specialties has open for Mechanical Engineer, preferably with experience in the use of steam for process and heating, as related to the manufacture and application of steam traps, control valves and similar products. To assist Chief Engineer in design, application and sales engineering. Location Eastern Pa. Send resume of qualifications, experience, when available and salary requirements to Box 1735. **Power Engineering,** 308 E. James Street, Barrington, Illinois.

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Established Philadelphia engineering and construction firm has permanent staff positions open for graduate mechanical engineers with 5 years minimum experience as Project Engineers in design of steam electric power stations involving project interoffice and client coordination. Salary will be commensurate with experience and ability. Excellent working conditions and liberal company benefits.

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Large engineering and construction firm engaged in central station, industrial, and chemical work has permanent staff position open for graduate mechanical engineer familiar with specifications and report writing. While many years of experience are highly desirabe, your merit will be given full consideration.

Salary commensurate with experience and ability. Excellent working conditions and liberal company benefits.

Applicants please submit full details including personal data, education, experience and salary desired in your reply. Write Box 1736. **Power Engineering,** 308 E. James Street, Barrington, Illinois.

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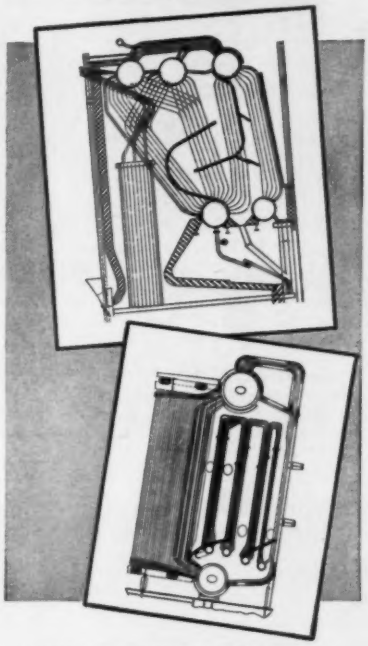

These important fuel-saving maintenance-reducing features are obtainable with Enco boiler baffles—*and only with Enco baffles.*

- **Streamlined gas flow**
- **Uniform gas flow**
- **Elimination of bottlenecks**
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- **Cleaner heating surfaces**
- **Less use of soot blower**
- **Special provision for expansion**
- **Easy tube replacement**
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Each application is designed on the basis of more than a quarter century of experience in this specialized branch of power engineering. Installations are made by skilled mechanics.

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CONSTRUCTION NEWS

Sitka, Alaska — Department of Light & Power, City Hall, is working on city's Blue Lake hydroelectric project. Work will include construction of a 116-ft-high concrete arch dam on the Metvetcha River, a 98 by 31-ft reinforced concrete powerhouse, installation of two hydroelectric generators, and construction of an 84-in. steel penstock, 400 ft in length. City has awarded contract for the work to start at once to the Morrison-Kuudsen Co, Boise, Idaho. Cost of the work awarded to the firm was reported to be about $1,770,775.

Riverside, Calif. — California Electric Power Co, 3771 W. Eighth St, has announced plans for the expenditure of more than $21,000,000 on major additions and improvements to company's generating and distribution facilities. This is up by $7,000,000 over the 1959 expenditures for this purpose. Of the amount, company has earmarked $9,400,000 for the construction of the previously approved cool water steam electric-generating plant near Barstow, Calif, on the Mojave Desert, which will have an initial capacity of 60,000 kw. More than $10,000,000 will be used for new facilities and improvement of existing facilities.

Sacramento, Calif. — Sacramento Municipal Utility District, 1708 59th St, Sacramento, Calif, has announced contract award to the Gibbons & Reed Co and J. A. Jones Construction Co, 325 W. Ninth North St, Salt Lake City, Utah, for $1,800,000, for the construction of a diversion dam, a unit of the Upper American River project, in El Dorado County. Work will proceed at once for completion by the fall of 1961.

San Diego, Calif. — Atomic Energy Commission, 1901 Constitution Ave, N. W., Washington, D. C., has authorized plans for construction of a 400-kw experimental low-temperature process heat reactor to supply heat for water distillation plant for the Department of the Interior, Saline Water Dept, at Point Loma, near here. Sargent & Lundy, Chicago, Ill, is consulting engineer of the project which will cost about $4,000,000. The experimental reactor will be built to supply heat to the Interior Department's demonstration plant for desalting sea water.

San Diego, Calif. — San Diego Gas & Electric Co, 861 Sixth Ave, has begun plans for the construction of a new steam generating unit at its Bay Power Plan here. Installation, with an initial capacity of 142,000 kw, will be the second to date at the power plant. Work on the new facility has begun, and it is reported that the turbine generator will be furnished by the Westinghouse Corp, Pittsburgh, and the boilers for the unit by the Babcock & Wilcox Co, of New York. Plant is scheduled for completion by late 1961 at a reported $15,000,000.

Tracy, Iowa — Iowa Power & Light Co, 312 Sixth Ave, Des Moines, Iowa, is considering plans for the construction of a new steam electric-generating plant on large site recently acquired for the purpose, near here. Design details for the new facility are expected to be completed late this year with construction scheduled to start early in 1961. Plant will have an initial capacity of 150,000 kw and will be fueled by both coal and gas. The cost of the installation will be approximately $20,000,000 and will be placed in line by mid-1963.

Minneapolis, Minn. — Northern States Power Co, 15 S. Fifth St, has authorized plans for the expenditure of an average $1,000,000 per week on construction through 1960. Included in this budget is the completion of a $24,000,000 addition to company's Black Dog Power Station near here and a $4,800,000 start on a major construction program on an atom-powered plant near Sioux Falls, S. D. The outlay for the year is an estimated $56,000,000 and is part of a three-year program with a total investment of $141,000,000. New construction costs in 1959 totaled about $46,000,000.

Fairbury, Neb.— Department of Public Works, City Hall, has authorized installation of steam electric-generating unit in municipal power plant for increased capacity, including complete accessory equipment. New generating unit will have an initial capacity of 12,650 kw and will represent an investment when completed in 1961 of $2,200,000. Work should begin soon. Lutz & May, Kansas City, Mo, is the consulting engineer.

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Industrial or utility . . . thermal, hydro, internal combustion or nuclear . . . Kuljian power specialists have designed, engineered and supervised construction of more than one hundred power installations throughout the world. From project feasibility report through initial operation, Kuljian complete engineering services—fully coordinated under one management responsibility—assure long term savings plus initial economies.

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DESIGN • ENGINEERING • PROCUREMENT • CONSTRUCTION • REPORTS

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Denville, N. J. — Jersey Central Power & Light Co, and New Jersey Power & Light Co, have authorized a major expansion and improvement program of their utilities system, to handle anticipated growth over the next three years, involving an expenditure of approximately $98,000,000. Expenditure of this budget for increased power generating facilities, distribution lines, and substations, including operating headquarters and commercial buildings, will center largely in Morris, Ocean and Monmouth counties because of the influx of new industry and families. Company forecasts that by 1962, net system requirements should increase about 30 per cent for JCPL and about 24 per cent for NJP&L. Included are funds for about 55 substations.

Mineola, N. Y. — Long Island Lighting Co, 250 Old County Road, has announced that it has budgeted more than $48,000,000 for new electric and gas facilities on Long Island through this year. The figure exceeds the 1959 outlay by $3,000,000 and will put the company's total expenses in the area over the last five years at $236,000,000. Company announced that about $32,000,000 of the total budget would be spent on new generating plants and related equipment, and transmission and distribution lines and substations. New facility now under construction at Port Jefferson will open late this year with an initial capacity of 185,000 kw, and a similar plant begin soon at Northport, L. I.

New York, N. Y. — American Electric Power System, 30 Church St, has announced purchase of a new plant site along the southeastern shore of Lake Michigan for a new power plant. Purchase of the 480-acre site, about 9 miles south of St. Joseph, Mich, was made for the Indiana & Michigan Electric Co, a subsidiary of the system, which will build, own and operate the plant.

New York, N. Y. — Power Authority of the State of New York, The Coliseum Tower, 10 Columbus Circle, New York, N. Y., has authorized plans for installation of a 345-kv transmission line from Rochester to Syracuse, N. Y., substations, Monroe and Onondaga counties. Authority has awarded contract of $3,088,575 to the L. E. Myers Co, Chicago, Ill. Work will begin at once for completion early in 1961.

Goldsboro, N. C. — Carolina Power & Light Co, 419 Fayetteville St, N. C., plans a major addition to company's power plant here. Construction will begin at once on the installation of a 240,000-kw steam electric-generating station, to cost over $20,000,000, and scheduled to be completed by the summer of 1962. New unit will bring total capability of the plant to 420,000 kw, making it the largest plant on the utility's line.

High Point, N. C. — Municipal Utilities Department has plans in progress for expansion and improvements in municipal electrical distribution system and general plant improvement. Plans are under way on the installation of transmission and distribution lines in newly annexed areas around High Point. Expenditure is reported at about $2,200,000. Work on the project is slated to begin soon for completion by the fall of 1961.

Miamisburg, O. — The Atomic Energy Commission at 1901 Constitution Ave, N. W., Washington, D. C., has authorized plans for construction of a new laboratory facility at the Mound Laboratory, near here, for continuation of a research project that began early in 1959. The Mound Laboratory, operated for the AEC by Monsanto Chemical Co, conducts research on radioactive isotopes, reactor fuels, and disposal of nuclear wastes. Construction of the new laboratory-type structure will begin at once, according to a joint announcement of the AEC and Monsanto, and will have a working area of about 13,200 sq ft.

Piqua, O. — Municipal Electric Department of Piqua, O., has begun plans for extensions and improvements in municipal steam electric power plant here. Contract of $849,770 has been awarded to the Erie City Iron Works, 1422 East Ave, Erie, Pa, for the installation of a new steam electric-generating unit, along with auxiliary equipment. Work will begin soon for scheduled completion in the spring of 1961.

Mansfield, Pa. — General State Authority of Pennsylvania, 18th and Herr sts, Harrisburg, has authorized a budget of approximately $279,500 for an electrical underground-distribution system and general utility expansion at Mansfield State Teachers College here. Work is scheduled for completion late this year.

Richland, Wash. — Atomic Energy Commission, Hanford Operations Office, P. O. Box 550, Richland, Wash., has authorized contract award to the R. B. Miles Construction Co, P. O. Box 113, Mercer Island, Wash., for installation of exhaust air contamination facilities for existing reactors in 8 areas of the Commission's Hanford Works. Work is already under way and should be completed sometime late next year. Total estimate of installation cost reported to be $1,698,866.

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Are your air preheaters performing at only 50% of efficiency? Or, perhaps, are the tubes so clogged with scale that you have actually by-passed the units?

With Wilson super-power EP air motors driving heavy duty carbide bits, air preheaters can be *cleaned four times faster* than by any previous method. The Wilson way offers speed, efficiency and economy . . . does not injure the tubes. Wilson tube cleaners also are available for use with water power.

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ADVERTISERS' INDEX

Aerovent Fan Co., Inc.	*
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Airetool Mfg. Co., The	108
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Childers Mfg. Co.	54
Combustion Engineering, Inc.	36-37
Copes-Vulcan Div., Blaw-Knox Co.	16-17
Crane Co	*
Crane Packing Co.	102
Curtiss-Wright Corp.	*
Cyclotherm Div. National-U.S. Radiator Corp	*
Davis Engineering Corp.	*
Dearborn Chemical Co.	*
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Detroit Stoker Company	99
Diamond Power Specialty Corp.	27
Eagan Co., Inc., Walter H.	*
Eastern Gas & Fuel Associates	49
Edison, Thomas A.	*
Edward Valves, Inc.	18-19
Elliott Co.	112
Ellison Draft Gage Co.	*
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Erie City Iron Works	91
Everlasting Valve Co.	52
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Graver Water Conditioning	*
Green Fuel Economizer Co., Inc., The	115
Gruendler Crusher & Pulverizer Co.	*
Hagan Chemicals & Controls, Inc.	48
Hall Laboratories	*
Hamon, Inc.	*
Harco Corporation, The	*
Hills-McCanna Co.	*
Illinois Water Treatment Co.	*
Industrial Instruments, Inc	*
Information Systems, Inc.	*
Island Creek Coal Sales Co., The	Cover III
Johns-Manville	12-13
Johnson-March Corp.	*
Jordan Corporation	*
Joy Mfg. Co.	97
E. Keeler Co.	55
Kirk & Blum Mfg. Co.	*
Koppers Co., Inc.	*
Kuljian Corp.	118
Lear, Inc.	*
Leslie Co.	38-39
Librascope, Inc.	*
Lonergan Co., J. E.	121
Manning, Maxwell & Moore, Inc.	107
Marley Co., The	122
Massey Coal Co., Inc., A. T.	120
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Palmer Thermometers, Inc. ..... *
Panellit, Inc. ..... *
Peabody Coal Co. 101
Pfaudler Permutit Inc. 114
Pfizer & Co., Chas. 53
Pickands Mather & Company 33
Pipe Fabrication Institute 46
Pittsburgh Piping & Equipment Co. ..... *
Powell Valves, Wm. 24
Pratt Co., Henry 116

Raybestos-Manhattan, Inc. ..... *
Refractory & Insulation Corp. 110
Reliance Gauge Column Company ..... *
Republic Flow Meter Co. ..... *
Research-Cottrell, Inc. ..... *
Revere-Copper & Brass Inc. ..... *
Ric-wil, Inc. ..... *
Riley Stoker Corporation ..... *
Roto Div. of Elliott Co. 28

Sarco Company, Inc. ..... *
Schutte & Koerting Co. ..... *
Sims Pump Valve Co. ..... *
Solar Aircraft Co. 103
Spence Engineering Co. 111
Standard Oil Co. (Indiana) ..... *
Stephens-Adamson Mfg. Co. ..... *
Stickle Steam Specialties Co. 116
Stock Equipment Co. 22-23
Stone & Webster Engineering Co. ..... *
Superior Combustion Industries, Inc. 104

Taylor & Co., W. A. 121
The Terry Steam Turbine Co. 89
Thermo Electric Co., Inc. ..... *
Thompson-Ramo-Wooldridge Products Co. ..... *

Union Iron Works ..... *
United Electric Coal Companies, The ..... *
Universal Atlas Cement Co. ..... *

Valley Camp Coal Co., The 95
Vogt Machine Co., Henry 15

Western Chemical Company ..... *
Western Precipitation Corp. ..... *
Westinghouse Electric Corp. ..... *
Wiedeke Co., The Gustav ..... *
Williams Gauge Co. ..... *
Wilson, Inc., Thomas C. 119
Wolverine Tube Div. ..... *
Worthington Corporation .....Back Cover

Yarnall-Waring Company 8-9, 56
Yuba Consolidated Industries, Inc. 7

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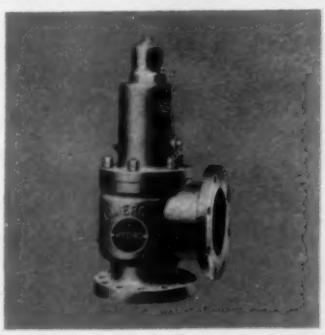
HOW TO SAVE WEAR AND TEAR ON MEN AND VALVES

by A. J. Schmidt, Chief Engineer

Power plant users of relief valves in liquid service are undoubtedly all too familiar with chattering. Valves hammer away, annoying plant personnel and running up maintenance bills.

Even with this undesirable operation, these



valves have been acceptable for application where the valves are seldom, if ever, called upon to relieve. For use under critical applications, such as pump by-pass, where the valve is normally open, or where opening is a common occurrence, it has been necessary to use expensive diaphragm or piston operated valves to eliminate objectionable chattering.

A new series of valves, called Lonergan Hydro-Valves have been under test in dozens of leading plants for the past three years. As a result, Lonergan can provide power plant operators with a valve that is guaranteed not to hammer, chatter or drum on any application, by-pass or emergency relief. At the same time, full-rated liquid flow is maintained. The chatter free operation is provided by a patented, unique design of throat, seat and baffle construction. Use of the Hydro-Valve helps to: save human nerves; prevent loss of plant fuel or product; reduce maintenance on valves and piping; and eliminate interference with delicate control systems. Hydro-Valves are available in all regular body and trim materials in sizes ranging from 1 to 8 inches.

Full details and descriptions are available in our new Hydro-Valve bulletin. Why not write for your copy today?

Alvin J. Schmidt

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1959 TOWER TESTS

Show Marley's Plus Performance Value

Here is the RECORD OF PERFORMANCE . . . consecutive results of all acceptance tests of Marley industrial Cross-Flow cooling towers made in 1959. This tabulation certifies Marley's ability to rate towers correctly and its single-minded purpose of applying them exactly as rated. Here are factual reports from 27 Marley installations in all parts of the country. Their specified capacities, operating conditions and types of service are as diversified as their geography, but tests uniformly emphasize the fact that these customers received a performance bonus that points up Marley Cross-Flows as vital investments in plant capacity and operating efficiency.

TEST NO.	TYPE OF SERVICE AND LOCATION	SPECIFIED CONDITIONS				TEST RESULT[4]	
		Gallons Per Minute	Hot Water Temp.	Cold Water Temp.	Wet Bulb Temp.	Degrees Cold Water Temp.[5]	Percent Capacity
1[1]	Generating Station—Mid-Atlantic	220,000	97°	78°	70°	+0.35°	+ 3.5%
2	Petroleum Refinery—Gulf Coast	3,500	95°	83°	70°	+ .47°	+ 4.0%
3	Generating Station—Southern	20,000	100°	85°	78°	+ .19°	+ 1.9%
4	Generating Station—Rocky Mtns.	89,300	95°	82°	60°	+1.88°	+ 9.75%
5[2]	Generating Station—S. Atlantic	75,000	113°	90°	74°	+ .20°	+ 1.25%
6	Petroleum Refinery—Gulf Coast	8,600	105.8°	87°	82°	+ .45°	+ 5.8%
7	Appliance Mfg. Plant—E. Central	7,750	95°	85°	78°	+ .40°	+ 5.00%
8[2]	Petroleum Refinery—Gulf Coast	45,000	112°	89°	82.5°	+ .72°	+ 6.65%
9	Generating Station—Mid-Central	62,400	107.5°	90°	76°	+1.10°	+ 7.3%
10	Petroleum Refinery—N. Atlantic	12,900	115°	85°	78°	±0.00°	± 0.0%
11[2]	Meat Packing Plant—North Central	6,000	105°	85°	75°	+ .60°	+ 5.2%
12	Jet Engine Plant—South Atlantic	20,000	95°	85°	79°	+ .40°	+ 6.0%
13	Generating Station—Gulf Coast	65,000	104.6°	87°	76.5°	+ .45°	+ 3.3%
14[2]	Petroleum Refinery—Gulf Coast	17,500	111°	90°	80°	+ .47°	+ 3.5%
15[2]	Petroleum Refinery—North Central	4,150	110°	75°	68°	− .10°	− 0.6%
16	Petroleum Refinery—East Central	19,400	120°	85°	75°	+ .65°	+ 5.5%
17[2]	Petroleum Refinery—Gulf Coast	57,500	120°	85°	79°	− .17°	− 1.3%
18	Petrochemical Plant—Gulf Coast	15,000	115°	90°	78°	+ .70°	+ 5.3%
19[2]	Air Conditioning—Mid-Atlantic	3,600	95°	85°	78°	+ .70°	+12.6%
20[2]	Atomic Test Facility—North West	70,000	112°	87°	65°	+1.50°	+ 5.9%
21	Chemical Plant—Gulf Coast	1,350	155°	86°	81°	+ .10°	+ 1.4%
22	Air Conditioning—Gulf Coast	7,000	93.5°	86°	80°	+ .30°	+ 6.0%
23[3]	Petroleum Refinery—Central	60,000	120°	80.6°	70°	+ .25°	+ 1.84%
24	Paper Mill—South Central	10,000	116°	86°	79°	+ .05°	+ 0.25%
25	Air Conditioning—South Central	6,000	105°	85°	78°	+ .25°	+ 2.7%
26	Generating Station—Mid-South	38,000	103.2°	90°	80°	+ .70°	+ 5.4%
27	Generating Station—West Coast	34,000	96°	80°	70°	+ .42°	+ 3.75%

NOTES: 1) Total capacity four identical towers: results are average of tests conducted on two towers. 2) Cooling Tower Institute observer present during tests. 3) Test of tower remodeled to increase performance after more than 13 years of service. 4) Test results are adjusted to specified conditions. 5) + indicates lower cold water temperature than specified; — indicates higher cold water temperature than specified.

"TEST YOUR TOWER"—a brochure that details the Marley method of tower testing, and "ANALYZE YOUR BIDS"—one that presents a logical means of pre-purchase evaluation, should be in every engineering library. Your Marley engineer will gladly furnish copies or just send a request to

THE MARLEY COMPANY MARLEY **KANSAS CITY, MISSOURI**

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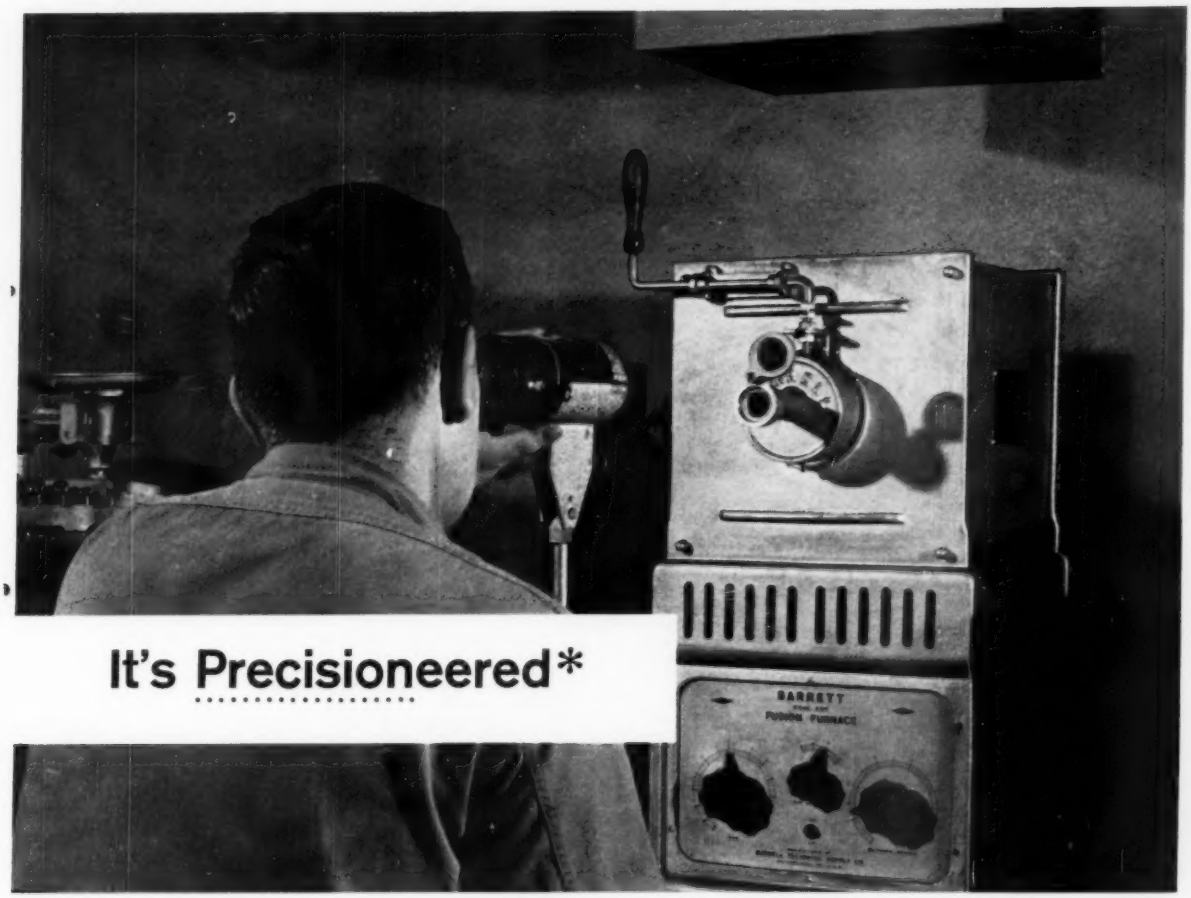
Why does Island Creek coal so often lower the cost per 1000 pounds of steam?...



It's Precisioneered*

An Island Creek technician uses the optical pyrometer to determine ash fusion point of a coal

* PRECISIONEERING at Island Creek is many things. Essentially, it is starting with superior seams of eastern coal . . . and preparing it to the exact specifications your burning equipment requires to produce steam at the lowest net cost per 1000 lbs. This involves the use of precision engineering techniques in the most modern preparation plants. It involves strictest laboratory controls. It involves far-reaching engineering service and evaluation studies. From start to finish it involves the career company attitude that has made Island Creek a leader to whom other leaders may look—with confidence. We'd welcome a chance to get down to net costs—with you and your plant people. Write. Or phone. No obligation, of course.

ISLAND CREEK
Precisioneered Coal

You can depend on Island Creek . . . a career company dedicated to coal

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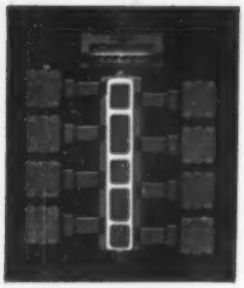
WILL YOUR NEXT BALANCED OPPOSED COMPRESSOR HAVE ALL OF THESE "HIDDEN VALUES"?



No, it won't! Even if you choose a Worthington compressor, you'll get only 23 of the 24 "hidden values" pictured below. (Just to pique your interest one is fictitious. For identification of the phony feature, see page 117.)

Compressors should be evaluated on performance, we think you'll agree. But performance is determined by factors which aren't easily checked against service conditions and data. These are the factors we call "hidden values." It will pay you to evaluate these values the next time you specify a compressor. Worthington Corp., Clinton Street and Roberts Ave., Buffalo 5, N. Y. 36-8

WORTHINGTON

OPTIC COMPARATOR is used to check connecting rod bolt threads for uniform angles, lead and form.

WIRE ALIGNMENT during assembly using electronic equipment minimizes field alignment problems.

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COMPOSITION TEST determines constituents of molten iron in each ladle before any casting is poured.

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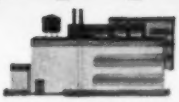
INTEGRATED DIV. includes foundry, manufacturing, sales, service and engineering in one location.

ULTRASONIC TEST— an advanced method of examining certain critical parts for internal quality.



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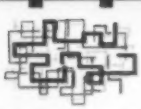

ANALOG/COMPUTER simulates wide range of actual operating conditions for optimum design analysis.

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KOLENE PROCESS removes impurities from bearing shell that weaken bond between it and babbitt.

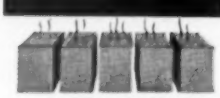
CAST-IN LUBE OIL SYSTEM with internally drilled oil passages eliminates crankcase "plumbing."

MAGNAFLUX AND MAGNAGLO inspections are widely used to expose surface imperfections.

FINISHED GROUND BEARING SHELLS provide positive full-contact backing for long life.

DESTRUCTION TEST of complete compressor cylinders verifies engineers' design calculations.

REMOVABLE DOWEL locks piston rod to crosshead — prevents turning due to loosened crosshead nut.



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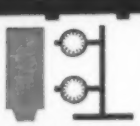
STEEL TIE BAR, keyed and bolted in place, strengthens frame and maintains the original alignment.



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